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• ANNUAL REPORT •

CALIFORNIA FOREST AND RANGE EXPERIMENT STATION

E. I. Kotok, Director — Berkeley, California

1939



★ BERKELEY HEADQUARTERS

● BRANCH STATIONS

- 1 Badger Well
- 2 Mount Shasta
- 3 Blacks Mountain
- 4 Swain Mountain
- 5 Feather River
- 6 Institute of Forest Genetics
- 7 Stanislaus
- 8 San Joaquin
- 9 Kings River
- 10 San Dimas
- 11 Devil Canyon

Vegetation Type Map by Forest Survey Division.

R-CAL
RESEARCH PROGRAM

February 17, 1940

ANNUAL REPORT OF THE
CALIFORNIA FOREST AND RANGE EXPERIMENT STATION
1939-1940

Contents

	<u>Page</u>
Director's General Report	
Introduction	2
Forest Management Research	
Pine Region	4
Redwood Region	15
Forest Fire Protection	20
Forest Genetics	24
Range Research	31
Forest Products	41
Forest Survey	44
Forest Economics	52
Forest and Range Influences	55
Interagency Flood Control Surveys	65
Library	67
Statistical Section	68
Publications	69
Project Status Sheets	

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DIRECTOR'S GENERAL REPORT

INTRODUCTION

The 1939 annual report attempts to place emphasis on some of the significant findings of the year, particularly as they may affect the tasks that lie ahead. Each of the major divisions of the Station prepared its own section of the report, which thus reflects the ideas of the responsible specialists who are working in a given field. A director of a station, with the task of coordinating the efforts of many workers, naturally might place emphasis differently. We feel, however, that in research free and open discussions of moot questions must be sought before experiments start, and critical review must be made of conclusions drawn from the facts adduced. The report, therefore, reflects a variety of viewpoints and not solely the ideas of the head of the California Station.

We have tried to avoid research for the sake of research itself. We have attempted, in the individual contributions to this report, to reflect the conception that research must be purposeful and must in the end contribute to better land management.

The number of immediately complex problems that confront managers of private or public timber lands exhausts the present research facilities of the agencies that must contribute to solutions. The best that we are able to do is to single out a few of the more critical of the problems for some detailed attention, and for many other important problems to offer short-cut methods as a sort of trial-and-error technique for the present. What should concern conservationists and foresters are the problems that will seriously thwart the probabilities of getting effective land management and proper forestry in the future because we fail today to build up a body of facts on which sound policy and action must be based.

Incipient problems begin to show up, problems that will have to be handled in the very near future without the benefit of pertinent information which can be accumulated only through the tedious process of research or the more costly and uncertain method of trial and error. A few examples can be cited to illustrate this point:

1. Through a fortuitous set of circumstances a belt of second-growth pine stands survived early-day logging and subsequent attacks of fire, a belt of at least a million and a half acres occupying the finest timber sites in California in the most accessible areas. Here is a potential forest property of high value; in character of species, in location, and in ownership ideally suited for small enterprise, ideally suited for picking up the slack of unemployment in "cow counties," and rich in possibilities of adding to the income of marginal farmers. Hacking and hewing in this belt has already started, with utter disregard of the outcome. Even those who are attempting to handle these lands properly lack basic information on how to perpetuate the crop, how to secure maximum yields, and how to maintain the desirable species. Practically nothing is being done in this important field except that a few rules of thumb are given to those who are interested, with no assurance that sound practices are really being encouraged.

2. We have extensive stretches of range lands adjacent to and intermingled with forest lands. Owners and land administrators are anxious to rebuild their property toward its original forage yield. The possibilities of revegetation, of conversion of present forage to more desirable species, may be very large indeed. The answer cannot be secured by wishful thinking or snap judgment. It will require a decade of hard work in research. The land is worth it if the industry dependent upon it is to continue to yield a profitable livelihood.

3. We have a vast area of brushfields extending throughout the State, some of it converted from original forest stands. At present it is subjected to severe annual fires in order to induce some production of forage. A half century of such treatment has been of doubtful value in producing forage and may seriously impair watershed values. No attempt is being made by owners to replace the undesirable brush species by desirable forage plants. Solution of this problem would substantially reduce fire losses in California and could offset shortages in forage. This problem cannot be solved by snap judgments, but again only through a reasonably well planned program of research.

4. Water development and flood control will continue to have a very prominent place in the development of the West. Under the general program for flood control and water development at least a billion dollars will be spent in California alone in the next 10 to 15 years. Funds for actual upstream controls are already provided by Congress. This work will continue for a long while. If ever a problem required careful consideration of its every aspect to insure sound expenditure of large public funds, this is an outstanding example.

One could enumerate many other illustrations, region by region. It would be unfortunate indeed if in the waves of economy that must periodically sweep the country, forest research should suffer unduly. I fear the price that will be paid will be but a further depletion of forest wealth.

The Station has continued to try to develop and extend cooperative effort with other agencies working in the field of conservation. This, of course, follows the policies of the Department as expressed by the Secretary, involving particularly cooperation with the numerous Federal Bureaus represented in California. We have continued to enjoy the benefits from cooperation in specific project work of many Divisions of the University of California, including Soils, Agronomy, Forestry, Animal Husbandry, Zoology, Giannini Foundation, and the Extension Service, all of the College of Agriculture; and Hydraulics, of the College of Engineering, as it affects the field of Forest Influences. The Division of Plant physiology, Genetics, Economics, and Geology have also assisted us with consultation and advice. In carrying out our research on experimental forests and ranges, we have received valuable aid from a stockmen's committee on range problems, from a lumbermen's group in our silvicultural studies, and from the Los Angeles Flood Control District on the Forest Influences program.

Recognition is developing in the State that the most effective attack on many conservation problems will require the closest coordination and cooperation of all the public and quasi-public agencies engaged in research.

FOREST MANAGEMENT RESEARCH

PINE REGION

Research directed toward practicable forest management in the Pine Region of California distinguishes four fields of problems: (1) the virgin merchantable timber which should be converted by a first lumbering treatment one step toward managed forests; (2) naturally restocked areas of unmerchantable timber requiring cultural treatments; (3) unstocked burned and cut-over areas requiring planting; and (4) the necessity for tables and standards as tools in every-day forestry and lumbering work.

Procedure is to sample the effects of lumbering practices currently feasible — methods-of-cutting studies; to experiment on a small scale with cultural treatments not current, but demonstrated to be useful elsewhere — stand improvement; to study the life habits and site requirements of the tree species with a view to formulating new conversion and cultural practices based on biological principles — silvics; and to test and demonstrate on a working scale the practicability of measures formulated from lumbering experience, cultural experiments, and biological principles.

Emphasis during most of the 29 years since work began, necessarily has been placed upon sampling the effects of cutting practices currently feasible. Expedient as such empirical research may be, its inefficiency long has been obvious; chance failures and successes can rarely be explained, hence other failures often cannot be avoided nor successes duplicated. In virgin timber conversion, for example, evidence continues to accumulate showing that no modification of single-cut lumbering now practiced, or considered economical, consistently effects restocking, retains pine in mixed stands, controls brush, promotes satisfactory growth, and maintains losses at reasonably low levels. Experimentation obviously should replace mere study of current cutting methods. With this in mind, recent efforts have been directed toward development of experimental forests, trials of new methods, and strengthening silvical studies. Routine measurements of the large number of sample plots have been much reduced, second-growth studies have become quiescent, and purely mensurational work has received little attention.

During 1939, work was concentrated on the ponderosa pine sustained yield experiment at Blacks Mountain, harvest cutting studies in pine types, silvical studies, planting tests in northern brushfields, and growth estimates for stands. Field work was curtailed where possible with a view to advancing long delayed publication of past results.

Results and Plans

Blacks Mountain Ponderosa Pine Management

About 550 acres of the experimental forest were cut over during 1939, bringing the area treated up to 1363 acres of which 1117 acres represent the preliminary salvage-insect control cutting, or the first step in the new flexible silviculture-utilization procedure being tested. Logs delivered during the season to the cooperating Fruit Growers Supply Company scaled 2,971,550 bd. ft.

Insect loss surveys, conducted annually by the cooperating Bureau of Entomology and Plant Quarantine since 1933, indicate that the salvage-insect control treatment has been effective in reducing losses during the three years of operation since 1937. In virgin timber, losses were 203 bd. ft., to the acre a year between 1933 and 1937; 63 bd. ft. in 1937 and 1938; and 100 bd. ft. in 1939. On treated areas, in comparison with virgin timber, losses were reduced 86 percent for the 1937 cutting; 88 percent for the 1938 cutting; and 95 percent for early spring 1939 cutting. It should be borne in mind that these comparisons were made while the insect cycle was on the decline. It remains to be seen whether or not the treatment will be effective when the bark beetle population is increasing.

An upward swing in the insect cycle is indicated by current seasonal surveys. The probability of increasing damage during the next few years emphasizes the urgency of more rapid coverage of the experimental forest. The project plan provided for salvage-insect control cutting on about 8000 acres during the first two years of logging. The conditions of the experiment will be changed somewhat should the smaller area logged be exposed to heavy infestations in the larger tract of untreated virgin timber. After considering this possibility, the cooperating agencies decided against introduction of direct control measures in the virgin timber. Cutting will be directed so as to round out a uniformly treated block, and coverage will be hastened insofar as possible.

The operating cost, log grade, and mill recovery studies progressed satisfactorily under cooperative direction of the Division of Products. The methods-of-cutting study annual block of six treatments was established. Stand improvement and other studies comprising the project again were deferred.

The California Forest Practices Committee of the Western Pine Association appointed the following three members an advisory council for advancement of the project: Kenneth Walker, Red River Lumber Company; Tom Oliver, Fruit Growers Supply Company; and Walker B. Tilley, Secretary California Forest Practices Committee.

Three groups interested in the project met at Blacks Mountain during the season: Supervisors of the northern national forests; 34 delegates to a log-grade conference representing the lumber industry, the Western Pine Association, Western Regional Office and Experiment Stations, the Forest Products Laboratory, and the Washington Office; 20 lumbermen, engineers, and foresters assembled to observe a test of mechanical felling and bucking saws.

A manuscript on the Blacks Mountain project was prepared and reviewed and is being revised for publication.

Harvest Cuttings

Conduct of the methods-of-cutting study underwent further change through shifting of effort to studies where better experimental control has been possible. Field work again was deferred for some 407 acres of older plots representing current lumbering, whereas 133 acres representing newer experiments in sugar pine-fir were remeasured and a block of six cutting treatments in ponderosa pine was established at Blacks Mountain.

Comparisons of Forest Service and economic selection cuttings of 1929 in sugar pine-fir, on four groups of approximately acre-size plots comprising 40 acres, show net growth for the Forest Service marking was 451 bd. ft. to the acre a year, whereas, for the economic selection marking there was a corresponding net loss of 126 bd. ft. The period of record is short and the areas are small, but the differences are consistent with results of the selection stand growth study, based on larger areas and longer periods, which indicated that increasing reserve volume, proportion of fir, and proportion of older tree classes tends to increase losses.

In ponderosa pine at Blacks Mountain, the second of ten annual blocks of cutting plots was established comprising 50 acres of each of the following six treatments: Heavy cutting, 96 percent of volume removed; standard Forest Service, 82 percent; modified Forest Service 62 percent; Blacks Mountain first cut, 19 percent; insect control marking, 20 percent; and check (no cutting). The third, or 1940 block was selected and surveyed. In this block the heavy cutting plot may be dispensed with to permit more rapid area coverage by the standard treatment.

The recently adopted lighter marking policy for Region 5 sales presents the problem of determining the effects of the change on development of residual stands. It is not feasible for the Station to carry the sampling job on the scale maintained in the older study of the original standard practices. As a compromise, it has been suggested that administrative personnel may determine the more important growth, loss, and stand structure changes by systematic application of the sale area-inventory procedure developed by the Station.

A report proposing experimental forest withdrawals in sugar pine types at the Stanislaus Branch was submitted to the Forest Supervisor and Regional Forester. A committee is to review the proposals early this spring.

Regeneration (Planting)

A report was completed for the Burney Spring (Blacks Mountain Branch) brushfield plantations comparing two-year results of planting and seeding with ponderosa and Jeffrey pines, after three brush eradication treatments: burning, stripping with trail-builders, and both burning and stripping. Third-year (1939) records sustained conclusions in the report that rabbits, rather than adverse physical site factors, were chiefly responsible for differences in survival and growth. During the first two seasons rabbits seriously injured the trees but affected survival but little. During the third season the effects of injuries were reflected in poorer survival. Survival for the burned and stripped area declined 3 percent to 86; for the burned only, 15 percent to 68; and for stripped only, 27 percent to 50. On the area stripped only, where damage was most severe, the average height of surviving trees has not changed since planting.

A plantation of ponderosa and Jeffrey pine 1-1 stock at Feather River Branch provided first-year comparisons for season of planting, method of storage, grade, and condition of bud development. Average survival was 90 percent although seasonal precipitation was exceptionally low. Stock spring lifted and spring planted without storage had a loss rate of only 5 percent; fall lifted-fall planted lost 7 percent; fall lifted-heeled in over winter-spring planted lost 10 percent; and fall lifted-refrigerated over winter at 38° F - spring planted lost 20 percent. Large and medium stock lost 9 percent whereas the small grade showed losses of 14 percent. Stock with firm winter buds had a loss rate only one percent higher than stock with no visible buds. Fall lifted-fall planted stock made the best growth and spring lifted-spring planted, the poorest. It appears that frequent poor survival in plantations, probably is not attributable to adverse site conditions associated with fall planting, but to unfavorable stage of development of the stock when lifted, or to deteriorative changes during storage and handling. Previous indications that small trees should be culled from planting stock were confirmed. Absence of winter buds probably is not a reliable indication of a condition of stock unfavorable to survival.

A study of ponderosa and Jeffrey pine seed grades at Feather River Branch showed that germination for large seeds was poorer than for medium and small seeds, but that size of 1-0 seedlings was proportional to seed size. The transplanting and outplanting phases of the study, to be completed in the next two years, should give further information as to the desirability of grading seed. A comparison of grades of 1-0 seedlings from ungraded seed showed that dominant seedlings from beds of prevailing large seedlings produced the largest 1-1 planting stock; dominant seedlings from beds of small seedlings produced the next largest 1-1 stock; and suppressed seedlings from beds of both large and small seedlings produced the weakest 1-1 stock. Several outplanting tests have confirmed poor survival

for small 1-1 stock and the desirability of more drastic culling in the nursery. It appears that special attention in culling should be directed to 1-0 seedlings at the time of transplanting. Studies to establish criteria for grading both 1-0 and 1-1 stock are being continued.

Feather River Nursery production was 19,500 ponderosa and Jeffrey pine 1-1 trees and 44,000 seedlings. Sowings were made to produce 35,000 trees for outplanting in 1941. The 1-1 stock was delivered to the Plumas National Forest for brushfield planting. Very little seed was available for collection.

The cooperative study of Northeastern Station hybrid poplars was continued at Feather River. Seed of Scots pine was received and a site was cleared for the International Union of Experiment Stations seed provenance study. A hydraulic press was constructed and new type rodent screens were made at Feather River for tests of seed-spot screening by the Biological Survey.

Silvics

Seasonal growth field measurements at Stanislaus and Feather River Branches were compiled for a five-year period. First indications from analysis are that the start of height growth varies significantly between seasons, 1000-foot intervals of altitude, and species; at 5000 feet, lodgepole starts growth earliest and white fir latest; ponderosa and Jeffrey pines start at about the same time; sugar pine and incense cedar start at similar, intermediate dates. The grand period of height growth does not vary significantly with seasons or altitudes, but is markedly shorter for sugar pine and longer for cedar than for the other species. The length of the growing period for ponderosa pine varies with altitude but not with seasons; an increase of 1000 feet in altitude is associated with later start of growth and a rise of 3000 feet with a shorter period of growth. When the brief publication being prepared is completed this study will be discontinued.

Seed crop survey cone counts, for the nine study areas at Stanislaus Branch and for the methods of cutting plots at Blacks Mountain, showed no effective seed production in 1939; consequently exposure of some two thousand seed traps was dispensed with.

The root pruning study, preliminary phase at Stanislaus Branch, was completed and first indications of the measurements are that fall planted ponderosa pines make no root growth until spring; spring planted trees show no appreciable root growth before 20 days from unpruned laterals and 40 days from pruned points; most of the new root growth represents elongation of unpruned laterals. Root pruning and handling injuries probably contribute to early summer losses from drouth in plantations where soil moisture has been demonstrated to be available. The water use phase of the root pruning study is being started in the greenhouse at Berkeley.

Brush competition study work was confined mostly to office preparation of material for publication. A survey of the Burney Spring plantation showed that, in three years after clearing, brush had reinvaded 33 percent of the area of planted rows that were stripped only; 37 percent of rows burned and stripped; and 65 percent of rows burned only.

Site factor measurements and seedling mortality records, in plantations and natural reproduction, strengthened previous indications of error in the common assumption that Pine Region sites are too critical for regeneration of native species because of climate. Deficient soil moisture apparently rarely accounts for seedling mortality in the absence of plant competition; high and low temperatures infrequently cause important losses in normal habitats. Adverse biological factors, such as rodents, insects, and brush competition, contribute largely to plantation failures and unsatisfactory reproduction on cut-over or burned lands.

The ecology of weedy shrubs doubtless warrants more serious study than has been possible. The extent and serious consequences of brush invasion on sale and other cut-over areas are not generally appreciated. Such facts as are available strongly suggest that tree seedlings cannot invade well established brush to the extent necessary for effective control. If so, even complete fire exclusion over long periods will not accomplish natural brushfield reclamation, and partial plantings may fail of their purpose. Also, it may be found desirable to revise planting policy to provide for partial planting on high site newer sale areas where seed crops have failed for two or three years after cutting, and on older cuttings now choked by brush, even though partial clearing will be necessary.

Mensuration

The growth prediction in selection stands report was brought near to completion. A final check of estimated and actual volumes show that the three charts now fit the data reasonably well. A study of sampling methods for the necessary variables indicates that a 1 percent systematic cruise by 1 x 2 chain plots centered in 20-acre units for 10,000 acres will give estimated means for reserve volume within 10 percent of true means, and for the other variables, within 15 percent.

An application of the above cruising method to cut-over land was prepared to provide management plan data and to determine effects on residual stands of the recently approved lighter marking policy. A manuscript was prepared, reviewed, and is being revised for publication.

To promote adaptation of cruising methods to requirements of the Forest Survey, arrangements have been made to include in the Region's airplane mapping program the Blacks Mountain Experimental Forest. The aerial photographs will enable savings of several thousand dollars through use of ground records already compiled. It may also be possible to photograph the Stanislaus center to enable extending tests to mixed stands on varied topography.

Summary of Plans for 1940

Blacks Mountain Ponderosa Pine Management

Experimental salvage - insect control cutting to be continued, increasing coverage of the forest as rapidly as possible.

Operating cost and mill recovery studies with Division of Products to be continued.

Continue cooperative insect control study with Bureau of Entomology and Plant Quarantine.

Harvest Cuttings

Establish and treat the third annual block of methods of cutting plots in ponderosa pine at Blacks Mountain.

Continue compilation for reports on permanent plots 5 to 29 years old in mixed stands.

Maintenance field work to prevent loss of tree identities on methods of cutting plots unmeasured for 10 to 12 years.

Regeneration

Burney Spring 1937 spring plantation to be reexamined once. Burney Spring 1937 fall plantation to be reexamined and two-year results reported.

Seed and stock grade study at Feather River to be continued.

Season of planting-method of stock storage study at Feather River to be reexamined once and report completed.

Scots pine provenance cooperative study to be established.

Northeastern Station hybrid poplar measurements to be repeated.

Feather River Nursery production of experimental planting stock to be maintained.

Silvics

Seed bearing study at Stanislaus Branch and Blacks Mountain to be continued.

Seasonal growth records to be compiled for publication.

Site factor data to be analyzed for publication and reorientation of field study.

Prepare report on preliminary phase of root pruning study and continue water use phase in the greenhouse.

Mensuration

Complete selection stand growth prediction report.

Continue assistance in application of sampling procedure to cut-over land surveys, Forest Survey, and other uses as required.

Cooperative Studies with Bureau of Entomology and Plant Quarantine

(Statement submitted by J. M. Miller, Senior Entomologist)

Blacks Mountain Sanitation Logging Experiment

Results in October 1939 on the compartments where high risk trees were logged in 1937 and 1938 show reduction of loss amounting to 90 percent as compared with nontreated compartments. These results were secured during a period when the infestations were not aggressive. The acreage logged to date amounts to only 15 percent of the total acreage to be covered.

Beetle infestations in the fall of 1939 are increasing and there is evidence that we are in the beginning of an epidemic cycle. The effectiveness of sanitation control will be subjected to a severe test under epidemic conditions in surrounding areas. It is doubtful whether the acreage cleared to date is adequate for a fair test of the method if these conditions develop. The questions of policy involve three courses of action in the continuation of this experiment: (1) let nature take its course under present rate of logging, (2) speed up sanitation logging so as to block out a large treated area as rapidly as possible, and (3) carry on direct control work in unlogged compartments until an adequate area has been covered by the sanitation cut.

Plantation Weevil

Damage by Cylindrocopturus longulus to 5 and 6-year-old planted trees in the Big Springs plantation was severe during the past season. As high as 90 percent of the older stock has been destroyed. Studies conducted by Eaton at the Hat Creek laboratory during the 1939 season have determined the seasonal history and habits of this weevil, and it has been found that burning of the infested trees during the overwintering period, October to April, will destroy the weevil population within the treated area. It was also found that the insect is fairly prevalent in reproduction of the surrounding mature forest, which may also have to be considered in a thorough control clean-up. Plans have been made to test control in the Big Springs areas next spring with CCC labor.

Scale Insects

Recent studies of Matsucoccus scale populations have shown that several species are abundant in eastside pine areas on trees showing definite crown injuries, such as flags and thinning of crown. Studies will be undertaken next season to determine the taxonomy, seasonal and life histories, and the probable role of these insects in the decadence of eastside pine stands.

Biological Control of Barkbeetles

Experiments to determine the effectiveness of predatory insects in the natural control of the mountain pine beetle have continued at the Miami laboratory. Results to date have shown that the possibilities for propagating or managing predator populations narrow down to one species, the blue-green Trogositid, Temnochila virescens.

Relation of Climate to Insect-caused Losses

A study was initiated last season by the Hat Creek laboratory to follow through a measurement of the weather factors along with an intensive record of insect activity. An area of 250,000 acres was selected with a series of 50 twenty-acre loss plots spaced so as to sample all of the hazard zones in the Hat Creek watershed. Weather, soil moisture, and growth record stations have been installed at five key plots for study.

Surveys

Detection survey coverage was extended during the past season to include westside areas of the Shasta, Lassen and Plumas National Forests not previously included in the survey program. This was due to aggressive barkbeetle outbreaks in the sugar pine-ponderosa pine types which up to this time have sustained only relatively light losses.

It is estimated that the 1939 loss estimates for the region will approximate 550 million board feet.

The Hazard Inventory is progressing on schedule, and if nothing interferes, field work for the eastside pine type will be completed by the close of the 1940 season.

Cooperative Studies with Bureau of Biological Survey,
Department of the Interior

(Statement submitted by E. E. Horn, Biologist)

Wildlife Related to Pine Regeneration

Rabbits and the seed-eating rodents are highly important factors in artificial and natural regeneration of pine forests. Rabbits clip large numbers of pine transplants on certain of the brushfield plantations in northern California. Seed-eating rodents take all or nearly all of the pine seed that is planted on these brushfields. Investigations have been under way for several years to determine the role of all animals, especially the rabbits and rodents, to regeneration. Only a limited time could be devoted to this study during the past year. Checks of the rabbit-damage plots on Big Springs and Burney Mountain brushfields were continued. As brush grows on the Burney Mountain experimental-burned areas and cover becomes abundant, rabbit clipping increases. There was far more damage during the past year to transplants on one area than in any previous year since it was burned and planted. Analysis of data has been completed and a detailed progress report is nearing completion. Highlight trends will be found in the project status sheet.

This project is not in the most satisfactory condition. It is a full-time piece of exceedingly important and urgent work that fully rates the technical requirement of a biologist in residence on the area for at least 10 months of the year.

FOREST MANAGEMENT RESEARCH

REDWOOD REGION

The immediate major problem in the redwood region is to harvest the large reserves of merchantable trees without excessive damage to trees now financially immature. Since most of the commercial stumpage is privately owned, research has been concentrated largely on short-term studies which may interest private operators in better harvesting practices. These short-term studies are of value also in formulating a long-term research program to be undertaken later when permanent facilities become available.

Progress was made toward completion of scheduled work on logging methods and costs for Mendocino County, redwood and Port Orford cedar volume tables, and reports of studies of redwood cut-over lands and natural reproduction establishment. On the only two long-term studies being carried on — establishment of natural reproduction following selective logging and growth rate of planted redwood — work was limited to reexaminations of permanent sample plots and a preliminary analysis of results. Only one new study was undertaken — the increment of redwoods left after logging. Some field work was done on this study in 1939. The possibility of acquiring a redwood experimental forest has strengthened during the past year, and an effort will be made to complete the short-term studies now in progress so that most of the redwood research effort can be shifted to the experimental area as soon as possible.

The general trend such research should follow has been discussed in a recent report, "Problem analysis for silvicultural investigations in the redwood region." The report points out the regional and national importance of sustained timber production in the redwood region, the present status of silvicultural knowledge and woods practices, and subjects for future research. Investigations of harvest cutting are especially important. Redwood is a tolerant species that occurs naturally in all-aged stands and is well adapted to selective treatment. Reproduction is best established under partial shade, and the present financially immature stand of 15 to 40 thousand feet per acre in the virgin forest should be saved as a basis for the managed stands of the future. The available virgin redwood timber supply is sufficient to maintain the present cut for 60 or 70 years, and the present problem is to convert these virgin stands to fully productive, managed stands with minimum loss and delay.

Results and Plans

Some of the most important results of the last year's work together with suggestions for the 1940 redwood research program are presented in the following discussion.

Establishment of Natural Reproduction

The manuscript, "Possibilities in the regeneration of redwood cut-over lands," which covers the extensive work first undertaken on redwood reproduction, is now being edited. Further statistical tests have recently been completed, and since they support the conclusions already reached, revision can be completed within a short time.

The second and more intensive study under this project, which was begun in 1936, provides the basis for determining the effect of such factors as density of residual stand, intensity of burn during slash disposal, exposure, and type and density of associated vegetation on the establishment of natural reproduction following selective logging. The fourth examination and remapping of the 300 reproduction quadrats established after logging in the Henry Creek area was completed in the fall of 1939. The rough draft of an article on the results of this study to date was recently completed. Stocking continues to be satisfactory, an average of nearly 90 percent of all-sized seedlings and about 40 percent of the larger seedlings having lived through four growing seasons. Intensity of burn has proved to be one of the most important factors, with the largest number of seedlings per square foot on areas of medium to heavy burns, the smallest number on unburned, undisturbed areas, and an intermediate number on lightly burned areas. The beneficial effect of burning is apparently due largely to the removal of slash and the consequent exposure of mineral soil. It was also found that exposed mineral soil on unburned tractor roads was very favorable for seedling establishment. The effect of exposure was about as expected, with the highest number of seedlings on north exposures, lowest on south, and an intermediate number on east and west.

Density of associated vegetation apparently had no significant effect on stocking, although there was a definite relationship between certain species and vegetation types and the number of seedlings per square foot. One of the interesting byproducts of this study is an accurate history of the vegetative succession on redwood cut-over lands. The temporary fire-wood type, which constituted a large part of the cover on the burned areas during the first 2 or 3 years following slash disposal, has already been largely replaced by more permanent species typical of the virgin redwood flora. It is proposed to reexamine the sample plots in 1940 and to analyze the data of this critical period, namely the first 5 years after logging.

Survival and Growth of Planted Redwood

This study was begun in 1937 as a follow-up of the investigation of the results of redwood planting. It is primarily a study of growth rate of planted redwood, but some data are also taken on damage and plant succession. It is planned to examine the sample plots in 1940 and subsequently at 5-year intervals.

During 1939 measurements were taken of 150 more trees, representing a wide range of conditions, which were used to check the preliminary tables. Copies of these tables were supplied to the Hammond Lumber Company and the Pacific Lumber Company for their use in cruising this fall.

At the request of the Division of Timber Management of Region 5 the basic data for these tables will be used in the preparation of a redwood taper table, which is needed for logging and milling studies and for appraisal work.

Tentative Port Orford cedar volume and taper tables have been prepared from measurements of 80 trees for use in northwestern California.

Increment of Residual Redwoods

Although this study was approved 3 years ago at the request of the Division of State and Private Forestry, it was not possible to begin the field work until 1939. Approximately 1,000 increment cores were taken from 400 redwoods in Humboldt County areas logged from 10 to 50 years ago with different degrees of cutting. Analysis of these cores will be made to determine whether they can be used, pending the availability of more reliable data from harvest cutting plots, to predict the yield of residual trees under different conditions. If this method is found to be practicable, the study will be extended to Mendocino County.

Northern Redwood Experimental Forest

In September 1935, after a preliminary investigation of the northern redwood purchase unit, the High Prairie Creek area was selected as the most desirable site for a redwood experimental forest. In view of the increasing possibility of acquiring this area, a more careful examination was made in 1939 and the desirability of its selection was confirmed. A definite recommendation for approval of the area as an experimental unit was made in a report dated September 30, 1939.

If this selection meets the approval of the Regional Office, definite plans should be made for the coordination of development activities in the newly acquired area.

New Problems

Most of the silviculturally important problems have received some attention, but several have never been attacked in a manner or on a scale that will yield satisfactory solutions or guidance to practice. Among these might be included treatment of poorly stocked, brushy, cut-over lands, improvement of the limited areas of well-stocked second growth by thinning and pruning, and fundamental ecological studies as they influence establishment of reproduction and subsequent growth. Of most pressing importance, however, are harvest cutting studies by tree selection; logging and slash disposal studies; and studies of the effect of different degrees of cutting on regeneration and yield. The maintenance of the redwood lumber industry at its present level requires that all redwood lands cut over in the future be kept in a productive condition. This can be done if tractor logging is extended and destructive slash disposal methods are largely eliminated.

Slash disposal is generally regarded as the most serious immediate problem in preserving residual stands. Some progress has been made by means of small-scale burning experiments on private operations but until the problem is adequately attacked it constitutes a severe handicap to the maintenance of permanent stands. Because such an attack involves problems in the technique of utilization and burning and their relation to regeneration and future yield, it must be carried on in cooperation with Products and Fire Research and requires full control of the areas studied. It is, therefore, a major reason for the early establishment of a redwood experimental forest, where slash disposal studies could be carried on in conjunction with methods of cutting investigations.

FOREST MANAGEMENT RESEARCH

FOREST FIRE PROTECTION

Current forest fire protection research in California has as its main objective, improvement in fire protection practice to the end that fire control may reduce present fire damage to a reasonable and acceptable minimum in reasonable relationship to costs. To accomplish this objective, work has been carried on in the two fields of fire behavior and fire control. The first is concerned with accumulation of factual information on the physical aspects of ignition, spread, and other behavior phenomena of forest fires. The second is concerned primarily with the development and application of new methods and equipment based on behavior information, analyses of past performance and accomplishments, and an understanding of current apparent weaknesses.

During 1938 a detailed analysis of the behavior project was made in an attempt to orient the research program in the light of conceived objectives. This analysis attempted to define the more important behavior problems, to establish objectives, prescribe research policy and study priorities set up by 3-year periods with provision for annual review. This analysis has aided materially in making up annual study work plans and in maintaining individual studies in their proper perspective.

In reviewing Experiment Station accomplishments in fire protection work, due credit should be given to Region 5 personnel. The long-experienced close cooperation between the Region and the Experiment Station has continued during the past year in all phases of the work. The Fire Weather Service of the U. S. Weather Bureau has also played an important part through continued active participation in the development of the fire danger rating system.

Behavior

The current fire behavior program is concerned primarily with studies of the principal individual factors influencing rate of spread. The objective in each of these studies is to determine the characteristic occurrence, methods of sampling and measurement, and type of influence on fire behavior of the factors concerned in order that they may be recognized and properly measured in studies of rate of spread and other behavior phenomena.

Principal emphasis in 1939 was placed on the study of forest fuels. Previous laboratory and field experiments indicated fuel distribution had an important influence on rate of spread of surface litter fires in the absence of wind. Study of nearly 300 fires in a 6x6-foot wind tunnel in 1939 indicates this fuel variable to have increased importance when the element of wind is introduced. Next step in the program is to determine if the same expressions for distribution applying to needle litter fuels remain valid for broadleaves

and other forms of fuel. This work contemplated for next year is also expected to indicate the fuel size and shape measurements necessary for correlating rate of spread variations with these different kinds of fuel.

Periodic examinations of green brush foliage quantity and moisture content, as a check upon observations made the previous two years, brought to conclusion a study of seasonal variations in the brushfields on the Shasta Experimental Forest. Large increases in both quantity and moisture content of the brush foliage were found normally to occur in June and July. These variations result in a decreased potential rate of spread in the brushfields during a period when rate of spread in other adjacent cover types is on the increase. Publication of the observed data is proposed for 1940.

Fuel moisture content studies to provide basic information necessary for proper interpretation of fire weather measurements and forecasts and of moisture indicator-stick observations have been continued in low priority for a number of years. Accomplishments during 1939 were mainly the development of experimental methods and equipment for measuring and continuously recording the variables judged to warrant consideration. The more important of those selected for study are air temperature and humidity, fuel surface temperature and humidity, wind velocity, insolation, and precipitation. The study is to be continued in 1940 in second priority, with special emphasis placed on development of instruments to insure continuous records and to free personnel for other work.

The study of forest fire ignition was undertaken on a limited scale in 1939. Work was limited to preliminary experiments in search for satisfactory methods for studying the influence of weather factors upon the probability of fires starting. These are as yet incomplete and will be followed up in 1940.

Control

Work in 1939 on chemical control of vegetation for firebreak and right-of-way maintenance was devoted mainly to demonstration and extension. Several additional demonstrations were installed during the year. Our soil sterilization data have been pooled with similar data secured by the University of California College of Agriculture to ascertain the influence of soil type upon sterilizing effectiveness of the more important herbicidal chemicals. Analysis of the combined data is now progressing. No new work is contemplated in 1940 beyond limited extension work and maintenance of records on previously established plots. Fire danger rating was extended to all forests of the Region in 1939. A second revision of the method of integrating fire danger measurements to derive class of organization was introduced before start of the fire season. Class of organization is determined in the current method from a fire load index which in turn is computed from spread

and ignition indexes. Class of organization is further modified by local departures from normal of human use and of stage of development of annual vegetation. Participation of the Experiment Station in fire danger rating ceased at the start of the 1939 fire season and will not be resumed until return to the project of absent personnel next July. Much development work remains to be done.

All available individual fire report data for the southern California forests since 1911 were tabulated during the past year as a preliminary step in the analysis of fire history in the south. This analysis is to form the basis for a problem analysis to serve as a guide in the development of a southern California research program. At least one more year will be required to complete the analysis of these tables and prepare the necessary summaries. In conjunction with this work during the past year, and in cooperation with the fire replanning organization, all Region 5 fire reports for the period 1925 to 1938 were recoded and punched on three 80-column cards.

Several special purpose analyses were made to provide needed information in the replanning project. The more important of these developed data on rates of spread by inflammability zones by forests, shown in the form of 74 photostat graphs. The Regional Office has one complete set of these curves and each forest received the section pertaining to it. The data were for use by Administration in the fire-control replanning project. This material is now being reshaped for mimeographing and wider distribution. Analyses of fire reports also yielded data on the size of suppression crew required, by rates of spread, which has already been applied in replanning and is being considered for outside publication as a joint article with the fire control division. No immediate plans have been made for a comprehensive analysis of all the data now on punch cards.

New Problems

The use of water is attaining more significant proportions in fire suppression work with each passing year. The ability of water to wet fuel surfaces is one important characteristic which makes it a usable suppression agent. But its wetting and spreading qualities are not sufficient to give maximum effectiveness when water is sprayed on the fuels generally encountered in fire suppression work. For 1940 a proposed new study in the control project is set up to investigate available wetting agents which may be added to water alone, or to solutions of chemical glazing agents, such as those proposed by the recent Forest Products Laboratory investigation, to increase their effectiveness.

The development of a formal fire research program for southern California is a major problem confronting the fire division at the present time. A few of the more outstanding apparent fire control problems have been given slight attention in the past, but no concerted effort has been devoted to determination of the fundamentally important problems or to assignment of priorities. This job

has been scheduled for attack immediately following completion of a current analysis of southern California fire report data with the combined forces of research and administrative personnel participating in the organization of a satisfactory program of applied research. This project is tentatively scheduled for completion prior to the 1941 field season.

FOREST MANAGEMENT RESEARCH

FOREST GENETICS

The Institute of Forest Genetics is charged with a dual responsibility, namely the production of new forms of timber trees that are superior to any now in existence for certain uses, and the pioneering of the genetical approach to the problems of forestry in order that general principles and workable techniques may be developed for general application by public and private forestry agencies.

The manner in which the Institute is attempting to fulfill this dual responsibility may be illustrated by the accomplishments of the past year. For example, experiments are under way to determine the feasibility of developing polyploid pines and "constant hybrids" of economic value. Possible methods of vegetatively reproducing pines are being given a thorough trial with the hope of finding some means by which unstable new forms that will not breed true from seed can be multiplied on a scale sufficiently large to permit their use in practical reforestation. In the phases of the investigations that call for precise comparisons and the elimination of the variable effects of environmental influences, the latest statistical designs and methods of analysis are being employed. Special attention is directed to the various indigenous pines of California, with a view to producing hybrids that combine certain of their desirable attributes in new forms.

The staff members are taking advantage of the concentration of scientists on the Pacific Coast, and are freely consulting them and are finding them more than ordinarily interested and helpful in this complex program.

Results and Plans

Hybridization - Possibilities and Accomplishments

Approximately twenty species of pine are native to California, but of them, only sugar, ponderosa, and Jeffrey are of importance as sources of lumber in California. These three species probably equal the average of the genus in vigor and they yield lumber of high quality. But because the sugar pine is seriously threatened by the white pine blister rust, ponderosa suffers heavy losses from insect pests, and Jeffrey is very restricted in its distribution, there is a real need for improvement in these three species. The chief objective of the hybridization program is to produce better timber trees, either by improving the species available or by breeding new forms. This objective involves the recombination of the desirable characters of the existing species. Fortunately, there are distributed among the economically unimportant native California pines, as well as numerous exotic species, many characteristics which, if properly combined, would yield new forms of silvicultural value far surpassing any forms now in existence. For example, Monterey pine is the most vigorous of all the pines; Coulter and Digger pines are exceptionally drought resistant, vigorous, and fairly frost-hardy; western white pine is capable of producing wood of high quality, and so on; so that

collectively, even the local pines provide characters in such diversified abundance that the possibilities of hybridization among them alone are exceptionally rich. When the entire genus is considered the field of hybridization offers infinitely more possibilities. Among these possibilities, if realized, some would be of local importance, others would be important chiefly to other regions, and still others would be important both locally and elsewhere. The breeding program embraces these local possibilities as well as the possible utility of new forms in other regions. Thus, its objectives are national, as well as local, in scope.

From the work done prior to 1937, the following hybrids appear to have been obtained:

<u>No. of Trees</u>	<u>Seed-parent</u>	<u>Pollen-parent</u>	<u>Age</u>
28	<u>attenuata</u> (knobcone)	X <u>radiata</u> (Monterey)	11 years
6	<u>echinata</u> (shortleaf)	X <u>caribaea</u> (slash)	7 "
3	" "	X <u>taeda</u> (loblolly)	5 "
8	<u>jeffreyi</u> (Jeffrey)	X <u>ponderosa</u> (ponderosa)	7 "
1	<u>ponderosa</u> (ponderosa)	X <u>arizonica</u> (Arizona)	7 "
8	" "	X <u>ponderosa scopulorum</u>	11 "
2	<u>rigida</u> (pitch)	X <u>taeda</u> (loblolly)	5 "

Considering the difficulties under which much of the early work was done (financial, lack of effective pollination technique, small numbers of ovulate flowers available in the arboretum, etc.) as well as the difficulty with which species crosses are ordinarily obtained, these results are highly encouraging.

Equally encouraging are the characters of some of the hybrids. The possibilities may be illustrated by two examples. The first cross between economically unimportant species, may become a form of considerable importance. It illustrates the possibilities of hybridization since it combines the cold-hardiness of the knobcone pine with the great vigor of Monterey pine, making it possible to utilize that vigor in colder regions than the natural range of Monterey pine.

The second hybrid is somewhat less vigorous than the slash pine pollen-parent, but more vigorous than the shortleaf pine seed-parent. As the natural range of the latter is to the north of the range of the former, the hybrid may offer a means of extending the vigor and quality of slash pine far beyond its present geographic limits. Moreover, the shortleaf seed-parent is one of the few pines that sprout vigorously from the stump. This capacity is insurance against complete loss of young stands from fire, since the trees will sprout until they are from ten to twenty years of age, thus making it unnecessary to replant burned areas or to obtain a new stand by other means. The hybrids have not yet been tested in this respect, but since hybridization often increases sprouting capacity, the hybrids may well possess this valuable attribute. Although it is not yet certain, there are indications

that it may be possible to produce these hybrids in large numbers at a nominal cost. Large scale production, rather than the difficulties of testing, is likely to be the chief obstacle to the use of promising hybrids, and, since economical production in large numbers seems to be a definite possibility, the field of hybridization offers promise. Other hybrids offer similar possibilities.

Numerous other crosses between economically important species were attempted in 1938 and 1939, but the results of these tests will not be available for several years. Most of these tests involve local species (jeffreyi, lambertiana, monticola, murrayana, and ponderosa) as the seed-parent.

It is planned to investigate methods of preserving the viability of pollen which cannot be used immediately because of the difference in flowering time of different species. The storage of pollen for long periods would greatly facilitate hybridization.

Polyploidy - Fixing New Forms through Chromosome Doubling

The use of hybrids in forestry depends on their cost and ease of production. In recent years geneticists have been giving a great deal of attention to the production of various polyploid forms of plants which may breed true from seed. The interest in polyploid plants revolves around the fact that many of the best field crops, fruits and cereals are produced by polyploid strains -- those having more chromosomes than the wild ancestors of these plants. During the past year it has been learned that the chromosomes of pines may be multiplied by treatment with colchicine. As increased chromosome number has never before been reported in any pines, this marks a distinct advance in showing that such a condition is possible. The trees produced in these first tests are very abnormal and generally have such abortive roots that they must be grafted onto other plants to keep them alive. However, they demonstrate that such treatments are a means of upsetting the cytological balance, and valuable new forms may result.

It has long been known that in pines fertilization does not occur immediately after pollination, as in most plants, but that it is delayed about a year; yet there has heretofore been no information on this vital point regarding the western pines. Recent cytological studies at the Institute have revealed that in ponderosa pine the fertilization period was between July 18 and July 23, some 14 months after pollination. It is planned to obtain similar information for other species during the coming year, as a guide to the timing of various treatments designed to induce chromosome doubling.

Vegetative Propagation - As a means of Reproduction True to Type

In horticulture the use of vegetative propagation has become the accepted means of all reproducing orchard trees. In forestry this method is used but little, partly because of the technical difficulties involved, but principally because of the

expense. In the case of ponderosa pine it has been learned that there is a marked decrease in the ability of the cuttings to root with increase in the age of the trees from which they are taken. While 65 percent of the cuttings obtained from 2-year-old stock developed roots, only 5 percent of those from 6-year-old trees were successfully rooted. Practically all cuttings from older ponderosa trees failed to root. Means of overcoming this condition of senescence will be sought since trees that are young enough to supply cuttings that will root readily are too small to yield any great amount of material.

The use of cuttings is but one means of vegetatively propagating plants. About 10 years ago a number of successful experiments in grafting and budding pines were conducted at the Institute. It appeared from those early tests that the limits of grafting are wider than those governing hybridization, and this has been borne out by recent and more extensive experiments. These tests indicate that probably any species of pine can be grafted onto any other. Grafts involving both white and yellow pines, for example sugar pine scions on Monterey stock have proved successful. Also, material taken from old trees has been successfully grafted onto young transplants. This provides a means of preserving valuable old trees. An intriguing possibility, to be explored further during the coming year, but already successful in a small way, is the grafting of needle fascicles to suitable stocks. This method may permit the multiplication of desirable specimens or hybrids on a scale that would be unattainable by any other method of vegetative propagation. It is made possible by the fact that bud initials exist at the center of each fascicle. Ordinarily these bud initials never grow out, but if properly stimulated, growth results.

Cytology - Specialized Aids to the Tree Improvement Program

To date about one-third of the hundred or so species and important varieties of pine have been examined cytologically. It is of interest that all the species of pines have 12 pairs of chromosomes that are remarkably similar in size and shape.

This cytological evidence indicates that with proper technique, crosses of distinct species of pines can probably be secured with much less difficulty than in many other genera where chromosome morphology and number vary materially from species to species. Moreover, this basic similarity leads one to suspect that pine hybrids, unlike most species hybrids, may possess a high degree of fertility. This is substantiated by the 19 pine hybrids known at the present time. Five of these are known to be fertile and none are known to be sterile.

Among angiospermous plants cytological study has revealed that when more than one plant is produced from a single seed there is often a difference in chromosome number between those plants. This phenomenon occurs in the pines, and work is under way to determine the nature of these seedlings.

The possibility that inherent vigor is correlated with embryo size is being investigated. A storm of controversy has centered about this important question for several years, but the issue has not been settled. For this reason several hundred pine seeds were fastened to a sheet of paper and photographed by the X-ray method, using less exposure than is required to produce genetic change in the embryos of seeds. These seeds were planted and growth records for one season have been taken. Measurement of embryo size, as shown by the X-ray photos, has been made and these data will be analyzed for correlations. If inherent vigor proves to be a function of relative embryo size, the selection of vigorous strains will be much simplified.

Physiology - Studies that Facilitate Genetical Research

An effort is being made to detect hereditary vigor by measuring the hormone content of pine seedlings. Tests made during the past year indicate that fast-growing plants have more growth substance than slow-growing trees, but the distribution of growth hormone in a shoot is so erratic that it is not yet possible to draw any final conclusions. The principal difficulty is to distinguish between vigor that is hereditary and vigor that results from the action of a favorable environment.

The need has long been felt for more knowledge of the interplay between heredity and environment. As one step in this direction, studies dealing with the influence of variable environments on ponderosa pine have been started with seedlings using the technique developed in the Plant Nutrition Department of the University of California. These studies demonstrate that ponderosa pine seedlings need liberal amounts of nitrogen, potassium, and phosphorus, especially the latter, while very small amounts of calcium and magnesium are needed for normal growth. These controlled environmental experiments will be continued.

Dendrology - Base Studies for nearly all of our Investigations

A dendrological study of different species and strains of pines on which experimental work is being done at the Institute has been initiated. This is necessary because the separation of all material, whether geographic races, natural or artificial hybrids, species, strains or varieties is dependent on the visible differences between plants. Many trees in the arboretum were grown from seed that was sent in under the wrong name, and before the back data pertaining to these trees can be analyzed and published these trees must be correctly determined. Another contribution of dendrology is that of securing propagules or seeds of unusual or especially promising trees reported from the field by various foresters or botanists, or encountered in the herbaria of California schools. Such acquisitions are not numerous but their value is great because they are usually mature trees producing an abundance of pollen and seeds for breeding work and the artificial production of such a mature tree would require many years.

New Problems

An important new problem is the production of inbred lines of ponderosa pine. These may be used at isolated stations for natural crossing to obtain seeds for planting stock, a method analogous to that now used so effectively in growing corn, where inbred strains, when crossed, produce plants of superior vigor and fertility. This hybrid vigor or heterosis of plants resulting from the crossing of inbred lines is a general and much used phenomenon. From 30 to 60 years, depending on the reproductive precocity of the species and the feasibility of basing selections on nursery performance, might be required to produce promising inbred lines of pines. Once produced, the inbred trees could be planted in selected sites and used as seed farms for centuries without any further work, whereas with corn, the inbred lines must be maintained by annual breeding operations. Thus, the initial cost of producing inbred pines is relatively high, but the cost of maintaining them is very low; whereas with corn, the reverse is true.

A physiological problem of much interest from the genetical viewpoint, but not as yet included in the Institute's investigations, is a study designed especially to bring out what influences the stock may have upon the scion or the resulting tree in grafted or budded pines. It is a common practice for the horticulturist to select special stocks to adapt orchard trees to particular soil and moisture conditions and to produce trees of relatively dwarf stature to facilitate the harvesting of the fruit. In forestry the needs are different, and perhaps the choice of the right stock will bring about increased vigor, drought or cold resistance, and early flowering.

The transect nurseries conducted by the Institute during the past two years have demonstrated very forcibly that such studies are capable of yielding contributions to our knowledge of the response of different strains to varying environments. For these preliminary studies of relative growth the present three transect stations at low, medium and moderately high elevations, (960, 2,730 and 5,700 feet), have proved adequate. But there is need for one or two nearby transect stations at much higher elevations (probably between 7,000 and 9,000 feet), where the conditions are sufficiently severe to cause a selective elimination of the forms of ponderosa pine that lack cold-hardiness. It will not be possible to establish any additional transect stations during the next year or two, but the matter should be kept in mind in future work plans.

RANGE RESEARCH

The broad problem of sustained, most profitable range use is especially vexing in this Region because research facts developed elsewhere in the West do not fit it and will not solve it. A range-forage cover highly unstable both in its plant ingredients and its yield of forage necessitates new approaches and new techniques by which to measure the effects on range of different treatments. Principles of satisfactory management rest upon such measurements.

In addition to grazing, range lands have many values and uses, private and public. This fact further complicates range-land use, not only for the livestock industry, the second-place industry in the State, but also for a much larger block of the population directly interested in watershed, wildlife, and recreational values of range lands. Illustrative of the difficulties in solving problems that arise from widely divergent viewpoints is the controversy over the benefits vs. detrimental effects of brush burning — an involved and unsettled question among leaders in the State.

For purposes of fitting our limited research effort into the general range-problem picture, the California area subdivides readily into five range ecological regions — central valley and adjacent foothills, eastside (of Sierra Nevada) region, westside timbered region, north coastal area, and south coastal area. Problems of both cattle and sheep ranges are found in all of these regions, but no detailed studies of management of sheep ranges have been undertaken. Thus far our program has necessarily been restricted to partial coverage of only the first two regions — the Sierra Nevada foothills of the San Joaquin Valley and the cut-over mountain ranges of the eastside.

A brief discussion follows on problems and on our progress and plans for these two groups of studies. Major cooperators are indicated. In addition, the excellent cooperation of the California Region pushed the studies forward in many ways not apparent in either the discussion or the project sheets.

Foothill Ranges

All going studies are centered at the San Joaquin Experimental Range, an area of 4,700 acres adjacent to the Sierra National Forest, Madera County. Main objectives are: improvement, maintenance, and most efficient use of these and similar foothill range areas, dominated by the unique type of annual plants which furnish nutritious forage during winter and spring but dry and deficient feed during summer and fall.

Agencies cooperating here with the Forest Service include: the University of California; the Bureau of Plant Industry, Soil Conservation Service, and Weather Bureau of the Department of Agriculture; the Biological Survey, Department of the Interior; the Division of Fish and Game, State of California; and California livestock

associations and community groups. Findings of these studies — backed by the livestock industry — apply directly to the whole granite-soils section along the Sierra Nevada, indirectly to 10 million acres dominated by the peculiar annual type of forage. The importance of these studies is virtually State-wide.

Range Forage and Ecological Relationships

The variation in forage make-up and its availability, previously reported, was again marked. Erodium botrys, for example, comprised 28.1 percent of the forage cover this season whereas in 1938 it made up only 15.5 percent. Bromus mollis made up 26.7 percent this year and only 17.0 percent in 1938, and four common Trifoliums combined made up 4.1 percent this season and 10.9 percent in 1938. Juncus bufonius was not recorded for a single one of the 720 sample plots studied in 1939 but during the years 1934-38 it made up from .4 to 3.1 percent of the forage cover.

Noteworthy are the parallel fluctuations of several kinds of plants, particularly the legumes as a group. When species of Trifolium are well represented in the flora, so are those of Lupinus and Lotus. Conversely, when one group is poorly represented, so are the other two.

Percentage fluctuations of certain groups are accompanied by similar shifts in total forage density. Many legumes have a dense spreading habit of growth in contrast to slender upright grasses. When legumes are abundant the total forage density is usually high; when they are sparse the density is low. This finding has a direct bearing on the value of forage density as a factor in forage-acre figures. Judging from the nearly average size of the crop produced this season with light rainfall, much of the rainfall during the winter months of wet years may be excess, or ineffective. The influence of climate on forage appears to be most pronounced early in the growing season and late in the season. Further relationships which are showing up between the forage crop and climatic factors give promise of value for short-range forecasts of the forage crop.

Plans for next year provide for continuing these studies and for intensifying them through establishment of a series of plots designed to measure the effect of close grazing and moderate grazing on forage yield.

Spring rainfall was scanty and forage, particularly in the swales, dried early and rapidly all over the Range. As a result the cattle began to lose weight earlier than in former years.

Grazing Capacity and Forage Utilization

During the past season, as in the three preceding years, only slight differences in the forage make-up and its availability have so far been apparent under the three degrees of grazing. However, the organic layer or mulch on the soil surface is decreasing in thickness in the closely used pastures. Continued studies will be required to determine the ultimate effects, especially in view of the fact that rainfall during three of the past four years has been considerably above normal.

Artificial Reseeding

Work has again been limited largely to survival testing in the nursery, although some recent increase has been made in competition-plot testing on the range. These tests are yielding information on behavior of the various species or strains under varying climatic conditions. For example, with light rainfall, perennials were subjected to extreme drought conditions — an experimental advantage in our testing program.

In the forage nursery several annual species have shown promise during the past season. Subterranean clover showed up especially well, and indications point strongly toward ultimate success with this species. One of the bur-clovers compared favorably, in both volume growth and seeding, with the common California bur-clover. Among the grasses tested for the first time, rye (Lolium rigidum var. strictum) made good growth and reseeded itself with a fine stand of seedlings.

Interest among stockmen in artificial reseedling is increasing even though results to date from our limited competition-plot testing out on the range do not justify recommending any species for extensive seeding. Still greater expansion in testing of these and other promising plants is a definite and widely recognized need.

Effects of Grazing on Rainfall Run-off and Erosion

Previous treatment was repeated: one battery of three plots was grazed heavily, one moderately, and another ungrazed served as a check. None of the plots showed any measurable erosion or any increase in run-off with close grazing, in spite of the fact some were grazed very heavily. The light rainfall readily penetrated into the soil. Run-off from all plots was less than 1 percent of precipitation.

Field observations following rains during the winter months showed no marked indications of erosion over the pastures as a whole, even in the closely used pastures. Rainfall during the period was below normal, with comparatively gentle rains during the forepart of the season. Only in cattle trails that lead up and down hills and in unattended roads and other badly disturbed places was there any pronounced run-off and erosion, and the amounts were very small.

Interagency Publication

Owing to the involved cooperative attack on numerous angles of the broad range problem, at the San Joaquin Experimental Range, and the increasing numbers of inquiries about results, there exists a definite need for an integrated report of progress. Agreement has been reached with the primary cooperating groups on the essential features of this joint effort, and organization of data has been actively in progress for several weeks.

Cooperative Studies with Animal Husbandry Division
University of California

Range Animal Husbandry

This series of exceedingly important investigations and experiments, an integral part of the program at the San Joaquin Experimental Range, was carried forward during the year without major change. Analysis of data, 1935 to 1939, has been completed. Results will be made available in a forthcoming joint interagency publication (see page 34). Selected highlights of findings and trends, submitted by Kenneth Wagon, animal husbandman, are abstracted on the project status sheet.

Cooperative Studies with Bureau of Biological Survey
Department of the Interior

(Statement submitted by E. E. Horn, Biologist)

Wildlife-Range Relationships

The Biological Survey continued cooperative work with the Station on studies aimed at fundamental determination of interrelationships of animals to forest and range practice, as an aid in wildlife management on wild lands. These very important range studies were intensified and pushed forward during the year along several broad lines.

Study of the food habits of predatory mammals and predacious birds was aided by the analysis of skats and pellets at the Berkeley laboratory. Arrangements are complete to institute preliminary studies of diseases and nutrition of the wildlife present on the Range. This will be in conjunction with population studies.

Studies of rattlesnakes continued, giving much additional data upon the feeding habits and in determining the function of rattlesnakes as predators influencing rodent populations.

Studies of animal populations and the factors influencing fluctuations in the numbers of each species of animals were a definite part of the studies. The effect of predators on all animal populations was considered, with detailed attention to the yearlong food of these predators. On intensively studied areas, the predator food habits and preferences are interpreted in terms of the entire biotic community. The aim is specifically to determine how these interrelated communities of living organisms function. Losses of ground squirrels on the Experimental Range continued, with death in some cases due to nutritional disturbances.

Rodent census continued on the Experimental Range with further refinement in methods. Marking of rodents and snakes continued, the recatches yielding data regarding composition of the population by age, sex, etc. Movement and migrations were further defined through these marked animals.

Details of these range studies, as well as numerous other studies and experiments having a bearing on forest and wild-land management, will be included in the annual report to the Chief of the Bureau. Concrete findings will be also included in the interagency publication now in preparation (see page 34).

Interagency Quail-Management Study

(Statement submitted by Ben Glading, Junior Biologist, Region 5)

This cooperative study continued under the direction of the Regional Office, the California Forest and Range Experiment Station, the Biological Survey, and the University of California. During the year the California Division of Fish and Game was included as a cooperator, with Gordon True, Jr. their committee representative. The study is trending away from detailed life-history research and toward an initial evaluation of management methods indicated by results to date of the life-history studies.

While it is felt that the two ground-squirrel test areas are a bit too small to give absolutely reliable data, the indications are that ground-squirrel control is of definite benefit to the bird population. The results of three years of nesting study are in close accord, the ground squirrel being responsible for the destruction of about one-third of the nests.

Two coincident or related facts were of especial interest during the past season: (1) water available for young quail was unusually scarce, and (2) the autumn population of quail was considerably lower than in the past two years. The winter and spring of 1938-39 was dry as compared to the preceding two years, and the onset of the summer drought in 1939 was earlier than in former years. Since the ground was not adequately soaked the swales, which usually remain green throughout the months of May and June, were dry during early May. Quail nesting in 1939 started in mid-April. The nests were scattered over the Range without relation to season-long water supplies that were known to exist. With the abrupt drying of forage and drying up of temporary water, quail nests were still in early stages of incubation. Although the adult quail can and do travel as far as 1/4 mile to obtain water, such distances are out of the question for very young chicks. Further indication that water may have been an important factor in the lower quail population of 1939 is the observed normal fall populations and old-young ratios contiguous to well-watered areas, both on and off the experimental area.

The population of quail in the experimental-hunt area was about half that of the 1938 count. However, it is felt that this reduction is in line with the general reduction noted above rather than a direct result of the 1938 hunt, aimed at a 25 percent kill. Cripple-kill ratios, birds-per-man-hour, and shells-per-bird were not significantly different from the 1938 figures; this indicates that at the present population levels such figures cannot be relied upon as a population index, and that actual census figures are required. It is felt that this hunting phase of the study should if possible be extended to larger areas to secure data more comparable with actual hunting effort in the foothills.

Mountain Ranges - Eastside Pine

The primary object of this research is to facilitate sound future management of range allotments, which generally include a combination of meadow, sagebrush, and timber types, in which uniform grazing is difficult to attain, depleted areas difficult to restore, land ownership involved, effect of sheep grazing on young pine seedlings unsettled, and competition between deer and livestock for forage locally becoming acute. Present work is being centered on national-forest problems in the eastside region of the State — the region east of the Cascade and Sierra Nevada divides.

Primary Purpose of Past Preliminary Research

Research effort in this region has been devoted primarily to laying a firm foundation for a sound research program to meet the problems outlined above. This has involved (1) working together with the California Region in making an analysis of the range situation and deciding on the studies to be undertaken by Research in their order of priority, (2) investigating the possibilities and limitations of field experimentations, and (3) systematically planned field work to develop experimental techniques.

Dividends from Preliminary Work

Past work has contributed to the progress made in preparing a problem analysis of the eastside region and in determining methods and limitations of field experimentation. Initial byproduct results of practical value have also been obtained.

Problem Analysis.— In the last meeting held jointly by Range Research and Administration on January 3 for the purpose of further analyzing the eastside range situation, the following subjects were tentatively approved for Research attention:

1. Utilization standards — particularly for
 - a. Extremely deteriorated ranges
 - b. Other less deteriorated ranges
2. Proper season of use
3. Fluctuation in forage production
4. Livestock control to improve distribution
5. Effect of livestock grazing on tree reproduction
6. Effect of logging on grazing capacity
7. Competition between deer and livestock for forage
8. Competition between rodents and livestock for forage
9. Reseeding (both natural and artificial)

These problems represent the initial views of Supervisors of seven eastside national forests and the Range groups of the Regional Office and Experiment Station. These biological problems should have a place in the ultimate long-range program. Formal economic studies are

as present data will permit and will prepare study plans with specific objectives for as many of the problems as it can undertake during the coming summer — a task estimated to be completed in March. Subsequent action steps will include: submission of plans for Washington approval, working out local policy points involved in use of experimental areas and livestock, and in construction needs. In the meantime the results of past work are being prepared in reports and manuscripts.

A Problem Look Ahead

Studies and experiments are in progress in only two of the five main ecological regions of the State (page 31), and in those two only a partial attack is possible. Groups of broad unsolved problems of varying degrees of importance in major forage-plant types in all of these regions, but not possible to undertake with existing outlook, include: possibilities and limitations of artificial reseeding, most satisfactory seasons of grazing, and intensities of grazing possible with sustained crops of forage. Examples of more specific projects for future program consideration are:

1. Expansion of reseeding work to permit:
 - a. Adequate studies in San Joaquin foothills.
 - b. Initiation of similar studies in high mountain ranges.
 - c. Cooperation with University of California and Bureau of Plant Industry on field-testing phase of genetics and plant-breeding programs in the State.
2. Balancing up initial management studies at both San Joaquin and Blacks Mountain Branch Stations, to permit adequate undertaking of high-priority phases not possible in current program.
3. Development of utilization standards for depleted areas (not covered in Utilization Standards Handbook) and refinement of standards for forage types in good condition.
4. Establishment of experimental range and work center for sheep-range studies in the Sacramento Valley (similar to the San Joaquin Experimental Range for cattle). Specifically requested by the livestock industry.
5. Undertaking of adequate study of the highly controversial question of brush burning.

FOREST PRODUCTS

The problems confronting the Division of Forest Products embrace a wide field ranging from those allied with silvicultural management practices to those of most interest to the consumer, whether he be an individual home builder or an industrial user of lumber or other raw material of wood. During the past several years the work of the Division has been concentrated on problems affecting lumbering and forest practice.

In connection with the desire of the Washington Office to test and where necessary revise the work and interrelations of Products units, the first of a series of intensive inspections was made at the California Station from mid-July to mid-August by Messrs. Trayer and Truax. A little later in the year C. L. Hill, who had been in charge of Products for 20 years, was transferred to the Director's Office and Products was taken over by L. N. Erickson.

One of the purposes of the current reorganization of the work of the Division is to give more consideration to the utilization problems, particularly from the point of view of the consumer of lumber, both for building and industrial purposes, which problems are recognized as having important bearing on forest management plans.

Results and Plans

One of the biggest advances in the field of Products work was the formulation in 1939 of recommended standard log grading rules for ponderosa pine, prepared jointly by the Northern Rocky Mountain, Pacific Northwest, and California Forest and Range Experiment Stations. The basis for these grades was data secured through detailed logging and milling studies conducted by each station. Of great value was the exchange of ideas and demonstrations of log grading by each station at the Inter-Station Log Grading Conference held at the Feather River Branch Station, November 27-29, 1939, attended by representatives of all the western Forest Experiment Stations, western Regional Offices, the Washington Office, the Forest Products Laboratory, the Division of State and Private Forestry, and the industry. It is hoped that the recommended standard log grading rules will be found applicable to ponderosa pine throughout its entire range for general appraisal purposes, and in the purchase and sale of logs, thereby meeting the distinct need for log grades in a growing ponderosa pine log market.

It was further agreed that where more refined grades are necessary for study or other special purposes they should be constituted by splitting the standard grades into sub-grades, which would thus be capable of being reincorporated into the standard grades and would make such data comparable between regions.

Logging and Milling Studies

Results of former logging and milling studies by the Products Division were used as a basis for a comprehensive report on log grading issued in July 1939.

Completion of Part II, "Office Procedure," of "Field and Office Procedures adapted to Logging and Milling Studies in the California Pine Region" has again been delayed due to the senior author having been transferred to the Atlantic Coast. It is planned to complete it prior to the opening of the 1940 field season.

Data on a mill study to supply needed information on tree values conducted at Blacks Mountain Experimental Forest in cooperation with the Fruit Growers Supply Company is being computed. Remaining field work on this study consists of grading and tallying of the air-dried portion of the lumber. This study was designed to furnish information needed in connection with the cutting systems being applied at Blacks Mountain to trees of various insect risk classes.

Upon approval of the recommended standard ponderosa pine log grades, previously referred to, it is planned to regrade cutting plots at Blacks Mountain, so that values can be computed on the standard basis.

There is active need for additional information on stand qualities and conversion values in the second-growth areas, on higher quality sites on the west slope of the Sierra, and in the redwood region where data are also needed to aid in formulating log grades. The Products Division plans to conduct logging and milling studies as required to meet such needs as they arise.

The Division has continued to act in an advisory capacity on local problems related to utilization, and it is expected that this phase of activity may grow as more work is undertaken with wood consuming groups.

New Problems

As mentioned in the foreword, one of the purposes of re-organizing the work of the Division was to give more attention to the utilization phases, both industrial and construction. The forests of the Region have a large production of low-grade lumber and a large potential production from species now largely left in the woods, constituting not only inefficient utilization but complicating future management plans. The Region also has within its boundaries important industrial areas, agricultural areas, and centers of population representing large potential consumption of forest products. Competing for these markets are woods originating outside the Region but having access to it by reason of low transportation costs. This distribution problem may have an important bearing on the possibility of increasing the consumption of local species within the Region and represents an important field of study.

Investigation of consumer needs and experience may reveal desirable and necessary revisions in manufacturing and seasoning practices to meet such needs.

In order to approach these utilization problems properly it is also important to learn from manufacturers their experience in attempting to market these low grades and lesser used species.

In the aggregate it is felt that the factors outlined have an important bearing on forest management problems in the Region. The Products Division plans to survey a number of these utilization problems during the coming year preparatory to undertaking specific work on a project basis.

FOREST SURVEY

Until July of this year the main activity of the Forest Survey Division has been that of field mapping vegetation types as a first step in the Forest Survey of California and western Nevada. At that time, the survey staff suffered a reduction of four men, leaving barely a skeleton organization. As a consequence it was decided to suspend field work altogether and to concentrate on two general lines of work as follows: First, to make at least a portion of the vegetation type map data that has been collected for nearly half of the region available for use sooner than otherwise possible by pushing the work in map publication and supplementary Forest Survey release preparation. Second, to complete a plan for the timber volume inventory phase of the Forest Survey. This re-orientation, therefore, should be kept in mind in considering this annual report, which as in previous years is presented under the following six activities: (1) vegetation survey and type map, (2) forest conditions (formerly called resources) map, (3) timber volume inventory, (4) land use studies, (5) ecological studies, and (6) herbarium.

Vegetation Survey and Type Map

Status

The present status and current progress of this phase of the forest survey are shown in the following tables:

Table 1.- Status of vegetation type survey December 31, 1939.

Operation	:	Acres	:	Percent
Total area of project		72,100,000		100.00
Field mapping completed		32,314,000		44.82
Field mapping completed, but field check required		6,844,000		9.49
Office work completed		26,367,000		36.57
Quadrangles published	(20)	5,854,000		8.12
Quadrangles in process of publication	(4)	1,419,000		1.97
Additional quadrangles submitted for drafting work prior to publication	(8)	1,975,000		2.74

Table 2.- Work completed January 1 to December 31, 1939.

Project area 72,100,000 acres				
Operation	:	Acres	:	Percent
Field mapping		308,000		0.43
Office work		3,307,000		4.59
Quadrangles published	(2)	715,000		.99
Quadrangles approved for publication ^{1/}	(2)	305,000		.42
Quadrangles submitted for drafting	(2)	300,000		.42

^{1/} In addition to those which had once before been approved.

Vegetation Type Map Publication

During the year the published vegetation maps were placed on sale by the University of California Press at a price of \$1.00 per copy. This arrangement was made under a cooperative agreement with the University. An information circular was prepared to give brief descriptions of the maps, to list available ones, and to explain how they could be obtained.

Forest Survey Releases

Following approval of our plan to issue a series of preliminary reports presenting the vegetation data collected to date, Forest Survey Release No. 1, "The vegetation types and forest conditions of the Santa Cruz Mountains unit", was completed and sent out to interested individuals and agencies. To date the report has been favorably received and has found a number of uses. Two schools located within the unit — San Jose State College and Santa Cruz High School — have adopted it for study in their conservation courses. It is also being used as basic material for an intensive investigation of land-use problems in Santa Cruz County being conducted by the Land Utilization Division of the Bureau of Agricultural Economics in cooperation with local citizens' committees.

Future plans call, first for the issuance of a similar report for the region in Nevada contiguous to Lake Tahoe. This priority has been set up because of the present activity of many agencies now interested in the area. This report is now well under way and, as Release No. 2 covering Douglas, Ormsby, and a portion of Washoe Counties, will be completed early in 1940. Release No. 3, grouping Los Angeles and San Bernardino Counties in southern California, also now in preparation, will follow shortly after. Their neighboring counties — Riverside, Orange, and San Diego — will then be presented in Release No. 4. It is expected that the latter two reports will result in increased sales of the many published type map quadrangles in the areas they will cover.

Forest Conditions Maps

These maps supplement the vegetation maps by supplying information on the condition and quality of lands now growing or capable of growing timber crops. No additional units were compiled during the year, but steps were taken to resume preparation of these maps upon a modified and improved classification basis in cooperation with the Regional Forester's office. Under this arrangement the Regional Office is drafting 15-minute (scale approximately one inch to the mile) quadrangle base maps upon which the Survey Division will superimpose the forest condition classifications. Blue-line prints with instructions for coloring will be prepared and thus the data will be made available for National Forest and other use.

Land Use Studies

For a number of years the Survey Division has participated with the Station's Economics Division and the University's Giannini Foundation in a land use study of the northern Sierra Nevada foothills. Much of the data basic to this study has been collected in the vegetation type survey and the Survey Division has compiled data for the study area on natural vegetation, forest stand conditions and sites, timber volumes and growth, fires, range carrying capacities, and land ownership. A joint manuscript is now in preparation and, as will be reported on in more detail in the Economics section of the Station's report, will be ready for the editor at an early date.

Timber Volume Inventory

For the past several years the Forest Survey has been developing the basis for a plan for conducting the timber volume inventory phase of the Survey. During 1936-37 it completed an experimental line-plot survey of 468,000 acres of forest land (Bidwell Bar Quadrangle). In this survey 1/5-acre plots were taken at 1/4-mile intervals along lines 2 miles apart. The trees were tallied by diameter and tree classes and the grade of the first log of trees over 20 inches D.B.H. recorded. In addition, as a basis for local volume tables and also the quality survey, diameter, height, and log grades were determined for two sample trees on each plot. This was followed by exploratory surveys during the field seasons of 1937-38-39, using aerial photographs as an aid in classifying forest types and stand conditions. From these surveys a method of classifying the timber stands according to broad stocking and stand structure classes was worked out. Furthermore, as a basis for determining the intensity of sampling as well as the size of the inventory job, the area of forest land within each of five regions as outlined on the accompanying map was ascertained by planimetering the statewide Natural Cover and Land Use Map compiled in 1934. These regions are logical, natural units and compare reasonably well in size with the Survey release units of the South and the Lake States. It is proposed to gauge the sampling intensity within each of these units, with the exception of the South Coast Range and Southern California Region, where the timber is of recreational and scenic rather than commercial value, to obtain a calculated accuracy of one percent as applied to the total volume of conifer timber.

In regard to size of job there are, as indicated in table 3, some 22 million acres of forest land to be inventoried. Also to be inventoried for their cordwood content are 10 million acres or more of nontimber forests comprising stands of oaks, pinon, juniper, etc., mainly of firewood value at the present time.

Table 3.- Acreage of California and western Nevada timber types and deforested areas by proposed timber volume inventory release units.

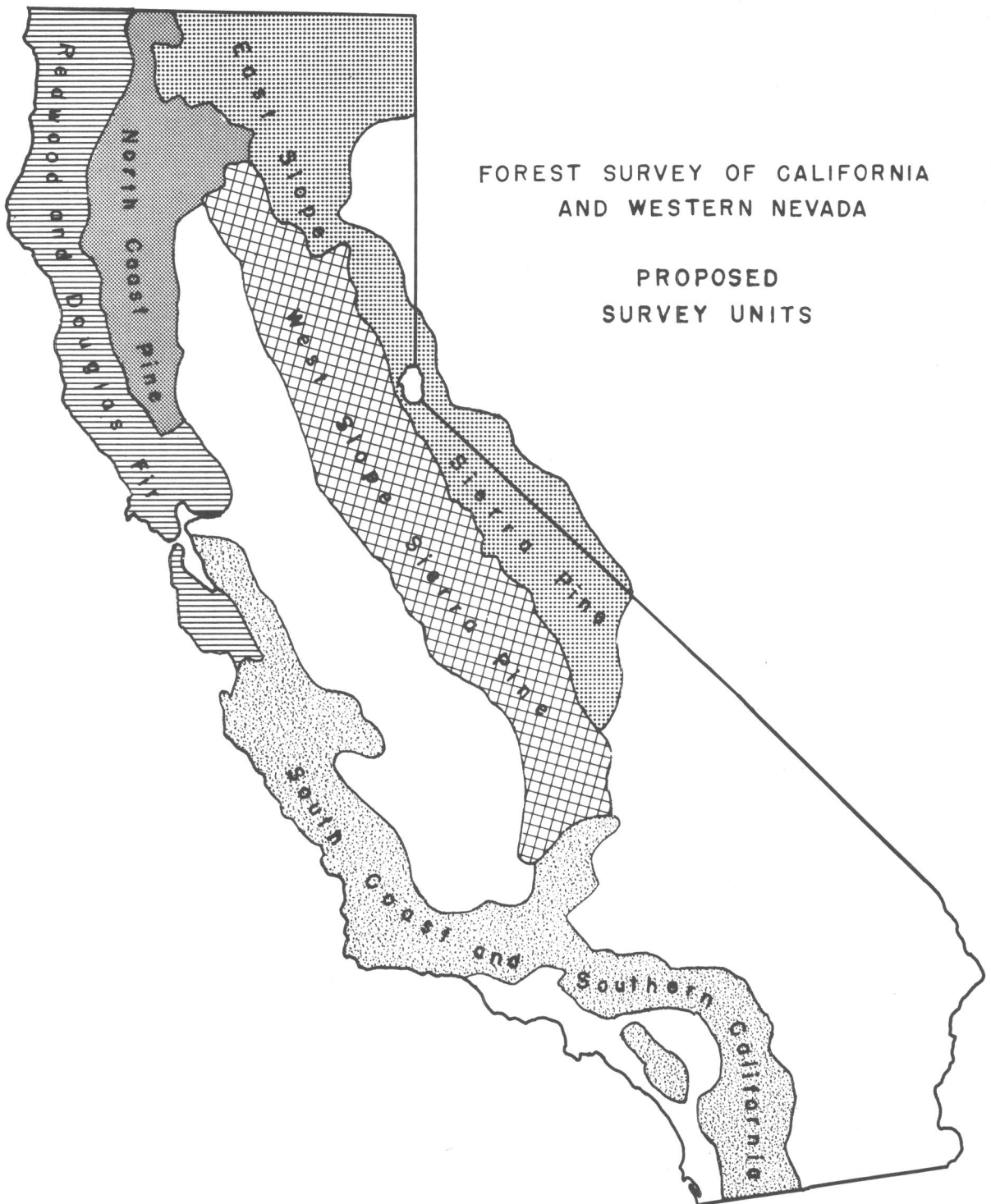
Regions or release units ^{1/}	Major types ^{2/}						
	Deforested:	pine-fir	fir	Fir	Redwood	Total	
West slope Sierra pine	727,000	5,196,000	-	1,113,000	-	7,036,000	
East slope Sierra pine	486,000	4,123,000	-	424,000	-	5,033,000	
Redwood and Douglas fir	1,017,000	270,000	1,806,000	235,000	1,668,000	4,996,000	
North Coast pine	661,000	2,763,000	576,000	244,000	-	4,244,000	
South Coast Range and So. California	69,000	500,000	-	-	19,000	588,000	
Total	2,960,000	12,852,000	2,382,000	2,016,000	1,687,000	21,897,000	

^{1/} For location see accompanying map.

^{2/} Area obtained by planimetering Natural Cover and Agricultural Land Use Map compiled in 1934 under Forest Survey direction.

With the above work as a background, a timber volume inventory plan is now in preparation. Because of the rapid headway aerial surveys are making in California and because of the many advantages and increased values resulting from the use of aerial surveys the plan is being made on the assumption that aerial photographs will be available. Specifically the present plan is being designed for application to the Tahoe National Forest and vicinity, an area of about $2\frac{1}{2}$ million acres for which air photographs on a scale 1:20,000 are now available and the Forest Service is now preparing a planimetric base map on a scale of 2 inches equals one mile. The plan will be submitted with the suggestion that final judgment on the feasibility of its application to the entire state be reserved until the completion of the Tahoe area. Although yet incomplete, a preliminary outline of the plan and its estimated cost is presented below.

PROPOSED SURVEY UNITS



The Area

Location.- The Tahoe National Forest and contiguous areas; embracing all of Sierra and Nevada Counties in California and portions of Plumas and Placer Counties, California, and Washoe County, Nevada.

Description.- Conditions typical of many occurring generally over both the proposed West Slope Sierra and East Slope Sierra Survey Units will be found in this area, extending, as it does, from the western foothill cordwood belt, through a full range of timber species and stand conditions, to the limit of timber on the eastern plateau.

Report Possibilities.- Complete reports for each of two predominantly timbered counties; Sierra (591,000 acres) and Nevada (623,000 acres). Most of the field data will also have been collected for Placer County (903,000 acres), and with comparatively little additional work a report for that area could also be prepared. All of the data would provide part of the basis for later unit and state reports.

Work Plan

- (1) Production of aerial photographs, including the necessary flying. (Already completed by the Regional Office.)
- (2) Construction of planimetric map, including the necessary ground control. (Being done by the Regional Office.)
- (3) Office delineation on photographs of (a) conifer and hardwood areas, with subdivisions into density and stand-structure classes, and (b) shrub, grassland, and cultivated areas. Commercial timber sites will be segregated from noncommercial sites.
- (4) Transfer of boundaries to planimetric map.
- (5) Office lay-out of line-plot sampling system. A preliminary analysis of the Bidwell Bar inventory seems to indicate that 1 sample plot will probably be needed for about each 480 acres of timberland (equivalent to 1/5-acre plots at 1/4-mile intervals along lines spaced 3 miles apart), which amounts to an intensity of 0.041 percent. (A more complete analysis may alter this figure somewhat.) Cordwood areas would be sampled less intensively.
- (6) Field sampling.
- (7) Collection of depletion data. (Either concurrent with or following field sampling.)
- (8) Office computations.
- (9) Analysis of data and report writing.

Cost Estimate

Production of aerial photographs and construction of planimetric maps.- Under the conditions of untrained and changing personnel in effect on the Tahoe project, the total cost to the Regional Office will be about 1.17 cents per acre; 0.31 cents for photograph production and 0.86 cents for planimetric map construction. With a continuing program and stabilized personnel, the total cost could probably be reduced to the neighborhood of 0.8 cents per acre.

The cost to the Forest Survey of one set of photographs would be about \$500, or 0.02 cents per acre.

Office work preliminary to field sampling.- About \$7,500, or 0.3 cents per acre.

Field sampling.- About \$7,500, or 0.3 cents per acre.

Depletion phase.- About \$1,000, or 0.04 cents per acre. (Not having any experience on which to base this estimate, it may be considerably off.)

Office computations.- About \$5,000, or 0.2 cents per acre.

Supervision and report writing.- All supervision, both field and office, and report writing will be by the present personnel, for whom the present regular appropriation, at least, would have to be continued. Since no additions to the normal requirements are needed, the total and per-acre costs are not included here.

Total cost to the Forest Survey, exclusive of supervision and report writing.-

	<u>Per acre</u>	<u>Total</u>
Purchase of photographs	0.02 cents	\$ 500
Preliminary office work	.3 "	7500
Field sampling	.3 "	7500
Depletion phase	.04 "	1000
Office computations	<u>.2 "</u>	<u>5000</u>
Total	0.86 cents	\$21,500

(Note — If it becomes necessary to conduct any basic studies (volume tables, etc.), additional funds would be required. Such work has not been included in this estimate.)

Time Estimate

Provided funds are made available July 1, 1940, the remainder of the year and the first part of 1941 would be required for working on the photographs and transferring data to the base map. Field sampling could begin early in 1941 and, if 4 crews were employed, be completed in about 5 months. Work on the depletion phase could be carried on at the same time or later. Office computations would begin as soon as sufficient plot data were available to prepare for the writing of reports during the winter of 1941-42.

It will be noted that no provision is made in the above plan for the preparation of a vegetation type map from the aerial photographs. This is because there has already been completed for the area a vegetation type map superimposed on the existing 30-minute U. S. Geological Survey quadrangles. While obviously not as satisfactory a map as can be prepared from aerial photographs, it should be adequate for forest survey needs. When, however, the inventory is extended beyond the areas so covered, a vegetation type map should be prepared. This will require additional field work estimated to cost about 0.75 cents an acre. Being independent of the inventory sampling, this work can just as easily follow as precede it. Thus the timber volume inventory phase could be completed first, if desirable, without being held up in any way by type map operations.

Ecological Studies

These studies are designed to put together in usable form the vast reservoir of material on plant distributions and successions obtained in the vegetation survey but which cannot be shown on the vegetation type and forest condition maps. The only work done during the year was a continuance of groundwork data compilation by WPA workers. The principal accomplishment was the abstracting of nearly 9,000 items pertaining to lumbering, fires, and vegetation from periodicals, newspaper files, etc., in the University of California and Bancroft Libraries at Berkeley and the State Library at Sacramento. While it is expected that the reading at Berkeley will be completed sometime during 1940, that at Sacramento will continue into 1941. Besides the continuance of this bibliographical research, plans call for the completion of a number of individual tree and shrub distribution maps for the South Coast Range Region to supplement those completed in past years for southern California.

Herbarium

The herbarium is maintained to check the identification of and to preserve the plants collected by the field type mappers to authenticate their work.

As in 1938, the herbarium work has been carried on entirely by WPA personnel. In addition to routine identifications and other work the following was accomplished:

(1) Mounted and catalogued 417 specimens for vegetation type map herbarium.

(2) Mounted 11,928 specimens for the University of California herbarium.

(3) Prepared and transmitted duplicates as follows: to the Forest Service herbarium at Washington, D. C., 221; to the University of California herbarium, 231.

(4) Papers published as follows:

(a) Notes on the genus *Arctostaphylos*

(b) The genus *Helianthemum* in California

(5) Manuscript prepared for publication on the *Arctostaphylos canoscens* complex.

During the year 1940, aside from routine herbarium work, research will be continued on *Arctostaphylos*, and one or two papers prepared for publication.

FOREST ECONOMICS

Studies of the Forest Economics Section are designed to analyze financial and social aspects of forest land use. Before desirable forest management is attained on private and public forest lands, many economic problems involving timber cutting methods, marketing, taxation, ownership, price stability, and investment returns must be solved. Studies of the costs and returns of timber production, with consideration given to the interests of both producers and consumers of forest products, are essential for the development of forest policies.

Land Utilization

The study of "Land utilization in the northern Sierra Nevada foothills", conducted in cooperation with the Giannini Foundation of Agricultural Economics at the University of California, has been brought several steps nearer publication during the past year. Problems of resource utilization have been more completely defined and the collection of basic data completed. Analysis of field data and preparation of text for several sections of the proposed publication have been finished.

The historical section of this report emphasizes the development of the characteristic patterns of land use that prevail in the Sierra foothills, as well as the economic dependence of both foothill and urban populations on the continued utilization of natural resources. The effect of climate in shaping the foothill land-use pattern has also been traced, since precipitation influences range use and irrigated agriculture, while temperature and local climatic variations determine the limits of crop production.

Sustained use of foothill forest lands is hindered by numerous economic problems. "Economic selection" logging, with heavy cutting of pine and the leaving of less valuable species such as white fir and incense cedar, tend to lower the potential value of foothill forests. The local lumber industry has been based mainly upon the production of high grades for eastern markets and the local disposal of low grades for box shooks, but as supplies of old-growth timber dwindle, adjustment of lumbering and marketing practices will be necessary.

Other completed sections of the proposed publication include an analysis of the timber resources by natural units, the foothill brush problem, the foothill fire problem, range utilization, and taxation. Some of these results are reported on in the Forest Survey section of this report.

Income from Second-growth Forests

A study of "Factors affecting income from second-growth forests in the Sierra Nevada foothills" was initiated and completed during the past year. There are about 1,500,000 acres of second-growth and restocking pine stands in the western Sierra foothills located on lands of high site quality and capable of producing average annual yields of 400 board feet or more per acre. Young vigorous trees

growing rapidly in volume and value make up most of the stands, while scattered mature trees often make possible the early receipt of income from selective cutting.

Lumber obtained from most second-growth trees consists mainly of No. 2 and 3 Common grades. Seasoning defects, including bowing and checking, are common, but good seasoning practices, cutting of the larger trees, and maintenance of well-stocked stands appear to limit losses from seasoning defects.

A favorable economic outlook for second-growth timber production is indicated by an expansion of markets in recent years, by diminishing local supplies of old-growth timber, by low production costs in the second-growth region, and by rising stumpage prices for young-growth timber. Returns from second-growth timber production have been limited however, by poor manufacturing and seasoning practices, low quality of timber, inefficient marketing organizations, and premature utilization of young timber.

The economic desirability of selective cutting to remove only the more mature trees in second-growth stands was indicated by the existence of wide variations in stumpage values and rates of value increment for different trees. A logging and milling study conducted at a small portable mill indicated that trees 14 inches in diameter, for example, showed conversion values averaging about 37 cents per thousand board feet, while 26-inch trees were valued at \$3.70 per thousand board feet. Small trees of low stumpage values increased in value at rapid rates when left in reserve stands, trees of 15 inches in diameter, for example, increasing in value at a calculated rate of more than 16 percent annually.

Well-stocked second-growth pine stands showed potential net forest earnings averaging more than \$1 per acre annually. Since second-growth forests are usually understocked, however, stand density in the foothill region must be built up through management and protection to attain such incomes. Markets for species such as white fir and cedar need to be developed to make silvicultural cutting feasible. Research on experimental forests is needed. Co-operative associations of land and mill owners might also be fostered to insure better cutting practices, efficient manufacturing, and effective lumber marketing.

Program for Next Year

The study of "Land utilization in the Sierra foothills" will be completed during the coming year and published in cooperation with the Giannini Foundation at the University of California.

The manuscript on "Income from second-growth timber production" will be edited and completed in the near future and the revised manuscript submitted for publication. One article briefing the results of the study and another article expanding the section on interest returns from forest investments will also be prepared.

An additional investigation proposed for next year involves a case study of the costs and returns of timber production in a selected area of the second-growth belt in the Sierra foothills. Such an investigation will involve (1) mapping and cruising a selected area; (2) analysis of types and intent of ownership; (3) a logging and milling study in an adjacent small mill to determine stumpage conversion values and log grade values; (4) a study to determine the value of timber for minor products such as veneer bolts; (5) sample marking to determine cut and leave volumes and values, and cutting methods; (6) analyses of growth and mortality to calculate current volume and value increment and probable increment during the next 20 or 30 years; (7) analyses of the possibilities of cooperative management of the various properties; (8) utilization studies to determine desirable methods of lumber manufacture; (9) utilization studies to improve manufacturing and marketing of lumber and timber products.

This study will be conducted in cooperation with the Management, Survey, and Products Divisions of the Experiment Station. Results will be of direct value both in the extension of forestry on all timberlands and in the proposed farm forestry program. Until an experimental forest is established in the second-growth area, such studies necessarily must be conducted on private lands but preferably on an area made up in part of national forest lands.

New Problems

In addition to a program of "cost and return" studies in sample areas of the California forest region, other important research problems recognized but not covered in the present program include:

(1) A study of the relative income from forest or grazing use in the marginal "tension zone" of the Sierra Nevada foothills. The brush-burning and fire problems of the foothill region center in part about this economic question.

(2) A marketing study for California timber species. Such a study would analyze local and regional species competition, the effect of transportation rate differentials, price differentials in local and out-of-state markets, and possible adjustments in uses of various timber species.

(3) A study of forest taxation in California, to determine the relative importance of forests in the State tax base, and to answer such questions as the effect of taxation on sustained yield enterprises, or the effect of severance taxes on the forest industry.

(4) A study of forest labor in California, designed to point up the problems of population support, relief, and community development.

(5) A study of forest ownership, correlated with the forest survey and management studies, to provide basic data for policies of forest land uses.

(6) A study of the financial and operating structures of the California lumber industry, designed to analyze problems of financing, competition, consolidation of holdings, etc.

FOREST AND RANGE INFLUENCES

The ultimate objective of research in Forest and Range Influences is to develop principles and practices of watershed management for application on the national forests and other similar areas.

The multiple use policy which obtains in national forest administration requires careful balancing of the relative values of the various uses, and from the standpoint of forest influences the effects of the various uses upon the water cycle, including both the yield of water supplies, and the regimen of streams with special reference to damaging floods. These problems involve a very complex pattern of factors, many of which require long-time study for an understanding of their effects. Others can be sufficiently analyzed by short-time experiments, by demonstrations or by observation of fortuitous events under natural conditions.

The Influences Division of this Station has been engaged upon a program of investigations since 1927, designed to attack the more urgent problems though not all of the factors involved in watershed management. Throughout the work, the administrative organization of the Region has given excellent cooperation.

Water conservation was the principal underlying theme when this program of research was initiated. During recent years the problem of flood control has received increasing emphasis due in part to the occurrence of several major floods and to the inception of the Flood Control Surveys by the Department of Agriculture. However, the solution of problems dealing with water supply still remains as one of primary importance even though the necessity for answering problems in flood control is more immediate.

A resume of the more important activities and findings of the past year are given in the following pages.

Influence of Natural Vegetation on Streamflow

Investigations concerning the relationship of vegetation to streamflow were carried forward on 27 watersheds located on the San Dimas Experimental Forest within the chaparral region of southern California and in the woodland-grass (Big Creek Unit) and fir-pine (Teakettle Creek Unit) types of the Kings River drainage.

Forty-four plots were employed in more detailed studies of vegetal influence on run-off in several chaparral subtypes and a second-growth pine forest. (Refer to the section on Soil Stabilization for the erosion aspects of both watershed and plot studies.)

Seasonal precipitation and run-off throughout the State were low last year in contrast to the preceding winter when record floods were experienced on both the Kings River and San Dimas areas. Average rainfall from 300 gages on the San Dimas Experimental Forest was approximately 21 inches, and from 100 gages on the Big Creek watersheds (Kings River) only 17 inches, both figures being less than 50 percent of the totals for the rain season of 1937-38. A storm during December 1938 brought more than 12 inches of rain to the upper portions of San Dimas Creek watershed. Flash flood flows carrying considerable debris were produced from the area in Fern Canyon that had been denuded of a heavy chaparral cover in the fire of November 1938. Flows from the other watersheds on the Experimental Forest were moderate during the entire season. A truly unusual storm drenched southern California late in September 1939, breaking all previous September records at Los Angeles. The San Dimas Experimental Forest received from 3 to 13 inches of rainfall with short periods of high intensity early in this storm. Due to the very dry conditions that prevailed prior to the rain, the storm caused no perceptible increase in the run-off from several of the watersheds and in others resulted in only moderate increases in flow.

Great volumes of precipitation and streamflow data from the San Dimas and Kings River studies have been compiled and summarized with assistance from the WPA. Though analyses of these data have not been made, a few completed summaries are presented here to show the trends and variations being revealed by the studies.

Full interpretation of these results cannot be made until the detailed field inventories of geology, soil and vegetation are completed. These inventories have progressed slowly with the limited time of technical personnel available for the work. Concerted effort will be made to complete these surveys, and to prepare maps for more accurate determination of watershed areas and topographic features. To date adequate maps have been completed for only 7 small watersheds on the San Dimas Experimental Forest and the 10 Kings River watersheds.

Emphasis is also to be placed upon the complete analyses, during the coming year, of precipitation and streamflow data. In addition to meeting the needs of Flood Control Surveys and requests from various other sources for results, these analyses are of utmost importance in planning the future course of experimentation.

Selected Summaries of Precipitation and Run-off

San Dimas Experimental Forest Watersheds

		1934-35			1935-36			1936-37		
		Run-off			Run-off			Run-off		
		% of			% of			% of		
Watershed		Precip-	Inches:	rain-	Precip-	Inches:	rain-	Precip-	Inches:	rain-
No. : Area		itation:	depth	fall	itation:	depth	fall	itation:	depth	fall

	<u>Acres</u>	<u>Inches</u>			<u>Inches</u>			<u>Inches</u>		
<u>Small Watersheds</u>										
Bell										
1	77	32.27	1.44	4.5	21.73	0.88	4.0	39.89	10.16	25
2	101	32.76	1.97	6.0	21.76	1.18	5.4	38.15	8.90	23
3	62	34.50	1.84	5.3	23.09	1.18	5.1	41.03	7.94	19
Fern										
1	35	40.38	0.43	1.1	23.77	0.11	0.5	40.34	1.36	3.4
2	40	41.02	0.55	1.3	25.71	0.17	0.7	43.15	1.97	4.6
3	53	41.27	0.07	0.2	26.46	0.05	0.2	37.33	0.49	1.3

Intermediate Watersheds

I	1555	31.31	2.00	6.4	23.06	1.49	6.5	41.46	5.84	14
II	1395	38.39	1.00	2.6	24.78	1.10	4.4	46.31	5.38	12
III	1370	35.29	2.56	7.3	23.23	1.37	5.9	44.33	8.94	20
IV	3584	36.30	2.03	5.6	23.82	1.31	5.5	44.85	5.53	12
V	2765	32.49	2.25	6.9	22.84	1.28	5.6	42.46	8.61	20
VI	8576	33.23	1.97	5.9	23.11	1.68	7.3	43.07	7.97	19
VII	1088	32.94	2.01	6.1	24.32	0.93	3.8	41.19	7.08	17
VIII	864	32.57	3.04	9.4	24.15	1.85	7.7	40.26	8.85	22
IX	749	34.53	1.39	4.0	25.54	2.11	8.3	41.73	9.03	22
X	864	33.70	2.59	7.7	25.73	1.54	6.0	41.30	7.41	18

Kings River Branch - Big Creek Watersheds

1936-37					1938-39				
1 ^{1/}	36				16.99	1.07	6.3		
2 ^{1/}	23				17.14	0.48	2.8		
2A ^{1/}	7				17.13	0.94	5.5		
3 ^{1/}	32				17.36	0.22	1.3		
4	21	34.08	6.56	19	17.40	2.40	14.0		
5	22	34.29	3.95	12	17.50	0.49	2.8		
6	28	34.51	10.32	30	17.54	0.57	3.2		
7 ^{1/}	24				17.47	0.44	2.5		
Area	192	34.29	6.94	20	17.32	0.79	4.6		

1/ Gaging stations not completed.

The important influence of underlying geologic structure upon streamflow has been very well demonstrated on the Fern Canyon small watersheds of the San Dimas drainage. Uniformly dense chaparral with heavy litter accumulation covered the 3 watersheds prior to the fire of 1938. Consistent differences as high as 50 percent in both maximum flows and seasonal run-off had been observed from these watersheds with cover intact. Some 250 soil borings showed that although the soil is shallow, averaging only 1.2 feet in depth, it is uniformly distributed over the entire area. It remained for a geologic study to reveal that differences in the underlying strata would permit a maximum of deep percolation in watershed No. 3 and a minimum in No. 1, facts which conformed with their respective characteristics of flow. Since the fire, the run-off from these watersheds has changed radically in character and amount, the latter now being proportionate to the area of the watershed in each instance. With loss of vegetation and litter it appears evident that the lowered infiltration capacity of the soil on all the watersheds no longer permits the difference in underlying geologic structure to affect the character of run-off as it formerly did.

Data from a series of 9 surface run-off plots, each 1/40-acre in area, situated adjacent to the Fern Canyon watersheds and denuded of cover during the November 1938 fire, are of value in explaining the behavior of the small watersheds. For example, during the storm of March 1938, with excellent cover on the plots, the measured surface run-off was approximately 1 percent of a total of 23 inches of precipitation. In contrast, the 13-inch storm of December 1938, one month after the plots were denuded, produced 2.3 inches, or 10 times the surface run-off measured during the March storm.

During the past four seasons data have been collected from the Tanbark Flat (San Dimas) series of nine 1/40-acre plots located in mixed chaparral cover now 20 years old. Surface run-off from these plots has averaged less than 1 percent of the rainfall, with a maximum run-off of 2 percent during the major storm of March 1938. Manipulation of the vegetation on several of the plots is planned for the immediate future. Selective thinning to produce a single stem stand of Quercus dumosa and clear cutting are proposed as indices to possible future management practices on watershed areas.

The succession of vegetation on the portion of the San Dimas Experimental Forest burned during November 1938 is being carefully observed. A characteristic invasion of annuals, principally Phacelia brachyloba, took place after the first rains. After the drying of this cover of annuals, the short-lived perennials, Lupinus longifolius and Nama parryi, began to dominate the area. Mustard seed sown on the burn last January produced a cover crop of 25 to 100 plants per milacre, though growth was delayed by near freezing temperatures for several weeks early in the year. Seed from these plants showed excellent germination of 90 to 96 percent. Rapid growth followed the September rain and a 20-fold increase in cover crop is expected this year.

Detailed observations on 12 phenological plots distributed over the Forest were continued throughout the year. The rain of last September followed by warm weather, simulating spring conditions, caused many plants to start their spring growth, thus advancing the season several months.

Water Utilization by Vegetation

During the past twelve years the problem of water utilization by vegetation has been approached largely through the use and study of plants grown in soil tanks, with somewhat less attention to studies of rainfall interception, infiltration and soil moisture in the field. Transpiration by riparian vegetation has also been studied in southern California by measurements of streamflow.

Methodology and instrumentation have occupied much time in all of this work. The North Fork infiltrometer, developed by the Division for measuring the infiltration capacity of soils, has been accepted during the year by the Flood Control Coordinating Committee of the Department as the standard instrument for use on Flood Control Surveys throughout the country. This instrument and the development of methods for the analysis and interpretation of infiltration data have disclosed another important approach to the solution of certain watercycle problems. A publication, "The construction, operation and use of the North Fork infiltrometer" will be ready for distribution during February 1940.

To date, with the exception of testing the instrument at North Fork, the Station has completed only one infiltration study employing the infiltrometer. This study, comprising approximately 100 determinations of infiltration capacity, was made on a 100-acre watershed near Friant, California, in cooperation with the Bureau of Reclamation. Although results of this study have not been completely analyzed, they have served to show the usefulness of the infiltrometer in measuring runoff and erosion hazards.

Preliminary data obtained from the series of 26 large lysimeters at Tanbark Flat on the San Dimas Forest during the first two seasons of operation are summarized here:

Rainfall, Run-off and Seepage

	Depth in inches		Total
	Seasonal averages		
	<u>1937-38</u>	<u>1938-39</u>	
Precipitation	47.03	20.13	67.16
Run-off	26.24	7.88	34.12
Seepage	0.43	4.07	4.50
Retention			
(+ evaporation)	20.36	8.18	28.56

The high run-off from these tanks with soil surface on a 5 percent slope and covered with fine excelsior is of interest. Further calibration of the units and analyses of the results will precede the establishment of vegetation on the lysimeters.

Current lysimeter studies in the consumption of water by one of the local grasses, Bromus mollis, at North Fork show that during the past season there were from four to five inches more evaporation and less percolation from a grass covered soil than from bare soil. These results cannot be considered as applicable to natural conditions, as the lysimeters do not provide for unrestricted run-off.

At Berkeley, thinning experiments on the Ceanothus cuneatus series of chaparral lysimeters showed no significant change in water relationships except when two-thirds or more of the vegetation cover was removed. A 68 percent reduction in cover caused about an 8 percent increase in percolation and a corresponding reduction in evaporation-transpiration losses. With complete denudation there was a 1 percent increase in surface run-off, a 35 percent increase in volume of percolate, and a corresponding reduction in transpiration-evaporation losses. In evaluating the results, however, it should be remembered that the climatic conditions prevailing at Berkeley are very different from those prevailing in the natural habitats of Ceanothus cuneatus, and that the experimental treatment probably permits much greater differences in the transpiration-evaporation losses than would occur under natural conditions.

Data obtained from the North Fork interception installations last season indicate that evaporation losses due to interception were less than 5 percent of the total precipitation, or slightly under those for 1937-38 season. The results of soil moisture studies substantiate those of the previous season and showed that higher interception and transpiration losses from plots with undisturbed vegetation were just about compensated by higher surface evaporation losses from soil of the annually burned areas.

Soil Stabilization (Soil Stability)

Measurements of erosion from watersheds and plots were initiated in southern California during 1927 to study the influence of vegetation on soil stability. These studies now involve detailed observations, annually or by storms when possible, of erosion from 20 watersheds and 56 plots at several locations and under conditions varying from complete denudation of cover to good timber stands. Results obtained clearly indicate the direct relationship of vegetative cover to soil movement, the latter of course being influenced by the amount and rate of precipitation and run-off.

Annual erosion measurements were started at the Barranca watershed of 44 acres in southern California in 1927, two years after the area was denuded by fire. Eleven years following the burn, during the winter of 1936-37, with a seasonal rainfall of 41 inches, the rate of debris movement was nearly 12,000 cubic yards per square mile, this being the maximum during the period of measurement. Data from this watershed disclose the continuing erosion-accelerating effects of fire for years after its occurrence.

Erosion rates from the Bell and Fern groups of small watersheds on the San Dimas Experimental Forest for two storms of 1938 are of particular interest due to the Fern watersheds having been burned over in the interval between the storms listed in the following summary:

Watershed	Age of vegetation	Rate of erosion Cu.yds./sq.mi.
<u>Storm of March 1938</u> (19 inches)		
Bell small watersheds	19 years	20,000
Fern small watersheds	Over 50 years	2,000 to 5,000
<u>Storm of December 1938</u> (12 inches)		
Bell small watersheds	19 years	Trace
Fern small watersheds	Denuded	5,000

Debris from the Fern watersheds during the March storm was largely the result of channel scouring in contrast to the erosion of slopes which took place during the December storm after the vegetation had been burned. This is substantiated by data from the Fern series of plots which were also denuded in the November 1938 fire. Erosion rates of 1 to 2 cubic feet per acre were measured from the plots before the fire. After burning, this rate has increased to 245 cubic feet per acre.

Soil movement from the Big Creek watersheds during the 1938-39 season was low due to subnormal precipitation. Rates varying from 12 to 54 cubic yards per square mile were measured in contrast with 10,000 to more than 20,000 cubic yards during the 1937-38 season and an average of approximately 150 cubic yards per square mile for the 1936-37 season.

The erosion rates on the Tanbark Flat series of plots with chaparral cover, now 20 years old, have not exceeded 2 to 4 cubic feet per acre during the last 4 years.

The current results of the North Fork, Bass Lake and Berkeley plot experiments are not significantly different from those reported during previous years. It is interesting to note that after burning the return of the chaparral-woodland-brush vegetation on the periodically burned plots results in an immediate decrease in sheet erosion and that a 4 to 6-year regrowth of the vegetation appears to afford almost full protection against sheet erosion. The control of gully erosion by vegetation, however, appears to be a somewhat slower process.

An experimental program in soil stabilization on a burned area was in progress during the year on a portion of the San Dimas Experimental Forest denuded by the 1938 fire. The measures used include: (1) mustard sowing, (2) planting of trees and shrubs, (3) trenching of slopes, (4) road drainage improvements including culverts, dips and masonry toe walls, (5) channel stabilization by construction of masonry barriers.

Plans for the Future

Publication of Records. The publication of 5 years of records of precipitation, streamflow and erosion for the San Dimas Experimental Forest is placed first in priority of future work. This work, involving a great amount of computation and detailed checking, was given a set-back last year by the loss of all of our trained WPA computers. A new group of workers, obtained in November, has been undergoing training, and the task is now scheduled for completion by July 1. The data will be issued in mimeographed form, without detailed analysis but with sufficient descriptive introduction and explanation to enable workers to employ the material with confidence. This form of publication has been decided upon in response to the continued demands from public agencies in California for our hydrologic data. During the past several years, upwards of 40 requests for data have been met by special compilations of from 1 to 20 pages of records. The proposed publication is expected to meet not only this local demand but many others which could not be met in the past. Following the publication of the first 5 years records, it is planned to issue annually in December a compilation, in mimeographed form, of records for the previous rain season.

Basic Inventories. Of equal importance with publication of basic data is the necessity for completing our inventories of physiographic features and vegetal cover which are essential to the interpretation of run-off records. The information required for each watershed and for the entire Experimental Forest is as follows:

1. Accurate determination of basal areas. During the past year the newly revised maps of the U. S. Geological Survey have resulted in areal corrections up to 14 percent in some of the intermediate watersheds. While the new map is a great improvement over

the old, it is still not sufficiently accurate for the intensive analysis to which these watersheds will be subjected. An accurate areal survey of the Experimental Forest and of the intermediate watersheds is needed, based upon intensive triangulation and traverse of the drainage boundaries. It is obvious that an error of more than 10 percent in basal area will have serious effects in the analysis of streamflow from a given watershed.

2. Calculation of slope surface areas. This also is an important factor in run-off analysis and cannot be accurately determined until the basal areas are first accurately surveyed. The relation of slope surface area to basal area has been worked out for the Fern small watersheds, showing the slope area to be 14.7 percent greater than the horizontal or basal area for the 3 watersheds, the average slope gradient being 56.2 percent.

3. Geological survey. Intensive geological studies have been completed for only the Bell Canyon and Fern Canyon small watersheds and for very limited areas in the vicinities of the various streamgaging stations throughout the Experimental Forest. An extensive geological map has been prepared for Dalton Canyon drainage, but the larger San Dimas drainage is still to be mapped. This survey must be more than a mere mapping of rock types and their position; it must include detailed studies of the nature and extent of weathering, faulting, and fracturing of the underlying rock, since these conditions profoundly affect the disposition of water which percolates through the soil. With present personnel this task will require 2 years more of time.

4. Soil survey. A detailed survey and study of soils of the entire Experimental Forest is required. This should yield a map showing the occurrence and depth of the soil mantle according to a classification of types which will be evolved by the study, and should indicate the field moisture capacity of the different types. Much additional information on soils will be required but the most urgent need is for this over-all soil inventory on a broad scale.

5. Vegetation survey. This will be an over-all mapping and recording of vegetation by types, stature, density, age, litter development and successional trends. To date only the Bell and Fern small watersheds have been so mapped. With present personnel the complete Forest map will require three or more years.

In the interpretation of streamflow from whole watersheds, detailed information on physiography and vegetation as described above is required in inverse proportion to the size of the watershed. It is apparent that the intensive analysis of the hydrology of small experimental watersheds such as the San Dimas Experimental Forest will require equally detailed knowledge of these features if the analysis is to have any meaning.

Research Program. In view of the considerable accumulation, during the past several years, of data on the effect of denudation by fire upon waterflow and erosion, no further experimental manipulations of cover by burning will be undertaken for the present. Instead, emphasis in the research program will be shifted to methods of watershed improvement by both forestry and engineering measures. A beginning in this work has been made in the Fern Canyon area, which was accidentally burned in 1938. This work will be completed, and in addition one or more of the intermediate watersheds of from 800 to 1000 acres in area will be subjected to a thorough program of watershed improvement for flood control and water conservation purposes. The plan for this line of study will be developed in cooperation with the Flood Control Survey. There is a strong feeling among certain groups that there is needed in southern California a sizeable demonstration of upstream flood control and water conservation measures. It is possible that the requirements of demonstration as well as those of research can be met by a controlled program on one or more tributaries within the Experimental Forest.

Prior to the selection of a stream or streams for this purpose, detailed analysis of the hydrologic records for the candidate streams will be made to determine whether existing knowledge of the streams's characteristics offer a sufficient base upon which to predicate the proposed improvement program. From the research standpoint it is desired to obtain definite quantitative measurements of the results of the control measures.

In the pursuit of this watershed improvement study, we shall not lose sight of other basic objectives of the Experimental Forest. Our regular Influences research will be continued, not only on the San Dimas Experimental Forest but also at Kings River, North Fork and Berkeley at a pace adjusted to available funds and man-power.

Channel Structure Study. Plans are in the process of formation with the Engineering Department of the University of California for a cooperative study of streambed barriers (check dams), sills and training walls, as employed in upstream flood control, upon the hydraulic characteristics of a stream and upon the movement of water-borne debris. The plans for this study are still too indefinite to permit further exposition at this time.

INTERAGENCY FLOOD CONTROL SURVEYS

Flood control surveys in this region have continued under the Joint Coordinating Committees 18 and 20, representing the Forest Service, Soil Conservation Service, and the Bureau of Agricultural Economics. The State Flood Control Committee continued their co-operation with the Department through the State Engineer and specialists of the University of California.

Preliminary Examinations

During the past year three public hearings, involving 8,000 square miles of watershed area, were held in cooperation with the Corps of Engineers, U. S. Army. The Department has participated in a total of 31 hearings that have included 37 watersheds (105,000 square miles) since the fall of 1937 when flood control investigations were authorized.

Seven preliminary examination reports were forwarded to Washington during 1939, reporting on 24,200 square miles of watershed area and recommending approval for detail surveys. The following watersheds were included: Pajaro, Kern, Kaweah, Tule, Santa Maria, Upper Sacramento, Salinas, Madera, Fresno, San Joaquin.

Survey Work Outlines

The preparation of survey work outlines (an intermediate step between preliminary examinations and initiation of final surveys) was authorized in August 1939 for six watershed groups distributed throughout the state and embracing 27,700 square miles. Three of these watersheds, the Pajaro, containing 1,300 square miles, the Kings-Kaweah-Tule-Kern group of 12,150 square miles, and the Santa Maria of 1,875 square miles, have been completed and forwarded to Washington. One of these reports, that for the Pajaro, was approved by the Washington Flood Control Committee and a detailed survey authorized. This survey is scheduled to begin on January 2, 1940.

Detail Survey Reports

The first survey report by Field Coordinating Committee 18, made in compliance with the Flood Control Act of June 22, 1936, was completed and submitted to the Washington Coordinating Committee in October. The report covered the survey of the Los Angeles River watershed, with recommendations for land treatment and structural measures designed to reduce the flood hazards at or near the points of origin.

Approximately 43 percent of the Los Angeles watershed is mountain land of which some 60 percent is publicly owned. Agricultural land makes up about 22 percent of the watershed with the remainder, or 35 percent, used largely for urban and suburban purposes.

The flood problem is intensified by the presence of highly developed urban and industrial areas on the alluvial plain between the Pacific Ocean and the south front of the San Gabriel Mountains. Reduction of flood damages in these areas will be accomplished upon completion of the comprehensive downstream plan of the Corps of Engineers and the Los Angeles County Flood Control District, supplemented by the proposed Department of Agriculture program of runoff and waterflow retardation and soil erosion prevention. The program includes the improvement of fire control measures; road erosion control and drainage improvement; improvement of the vegetal cover on mountain slopes; upstream channel control and stabilization; cultural treatment and changes in land use on agricultural lands; and secondary channel improvement in valley agricultural lands.

Survey work has been started on the San Gabriel watershed and is now well under way with damage surveys nearing completion by the economists and the field work on the agricultural and mountain areas about 50 percent complete.

In preparation for future work on the Santa Ana River watershed, 15 intensity-recording rain gages were installed to supplement the limited hydrologic data available in this area. Location of the gages was made after consultation with the Weather Bureau, San Bernardino County Flood Control District, and the San Dimas Experimental Forest staff. Maintenance of the gages will be provided by local cooperation.

LIBRARY

This year we completed two projects undertaken more than two years ago — the reclassification of the library and the compilation of the subject catalog. We also organized a branch library for the Institute of Forest Genetics at Placerville, California. This branch now has 178 books fully cataloged, and approximately 3,500 pamphlets arranged in pamphlet boxes by subject. Earlier issues of 58 periodicals are also on file. This collection of pamphlets and periodicals is larger than would normally be assigned to a branch, but much of it was acquired by the Institute during the years prior to its establishment as a branch of this station in 1935. At the San Dimas branch are 147 books, all fully cataloged.

We acquired 1,196 books and pamphlets, bringing the total to 9,683. A total of 12,070 cards were filed; of these 6,351 were new typed cards, including those for branch libraries. The remaining cards filed included those which required changes and additions in the process of reclassification. Of the 104 periodicals received, we routed 92 to the staff. From these magazines we indexed 147 articles.

With the organization of a central mailing list the Director designated the library as the agency for distribution of publications. We received 8,326 publications and distributed 5,279.

Circulation increased from 3,482 in 1938 to 3,861 in 1939. An interesting indicator of staff reading has been the monthly analysis of circulation by individuals and projects. It is expected that this will be a useful guide in helping to develop library service in the low circulation groups. It should be noted that our circulation figures do not include books borrowed independently by staff members from the University of California, nor does it include use of branch libraries. Most of our outside loans are from the University Library, but we have also had occasion to borrow from the Bureau of Public Administration, Berkeley Public Library, Pacific Gas and Electric Company, the Regional Library, Department of Agriculture Library in Washington, and from the Forest Products Laboratory.

The routing of magazines, monthly accessions lists, and circulation of books comprise but a part of the library service. In addition we have handled 115 reference questions on a variety of subjects which have been useful in the preparation of talks, research papers, letters, bibliographies, etc. Five specific subject-matter lists, totaling 36 pages were mimeographed and circulated to the staff, and 8 typewritten lists totaling 27 pages, for individual requests were prepared.

In November we started a one page publication LIBRARY NOTES in which brief abstracts of selected publications are presented. Another feature of the reference service under library supervision was the preparation of 8 translations from French, German, Spanish, and Russian.

STATISTICAL SECTION

It is the function of the Statistical Section to make statistical analyses at the requests of the various Divisions. During the year 1939 the personnel of the section has numbered 16, of whom 13 are WPA clerks. The section has been called on for services requiring both routine calculations and advisory work. In addition a considerable fraction of the Section's time has been devoted to keeping up with the current statistical literature in order to utilize in current routine project work the fullest benefits from new trends in methodology and statistical design.

On specific project jobs our records show the following distribution of time among the various divisions:

	<u>Man-days</u>	<u>Percent</u>
Forest Management Research		
Pine Region	1320	44.5
Forest Fire Protection	515	17.4
Forest Genetics	867	29.2
Range Research	94	3.2
Forest Products	74	2.5
Forest and Range Influences	95	3.2
	<u>2965</u>	<u>100.0</u>

The two major jobs in connection with Forest Management Research - Pine Region studies were: (1) Preparation of permanent records summarizing the Blacks Mountain Experimental Forest cruise data for 1933-34, and (2) Statistical analyses in connection with random line sampling studies.

The main work for Forest Fire Protection was the statistical analyses in connection with chemical maintenance of firebreaks.

The main accomplishment for the Institute of Forest Genetics was the analysis of the 1937 progeny test data, obtained from the nursery laid out according to Dr. Yates' three-dimensional quasi-factorial design. On the basis of the results of the analysis of measurements of 2-year-old seedlings selections for planting were made. From a statistical point of view this experiment is noteworthy as being one of two existing experiments based on this particular design, and the only one of such large proportions.

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January 1940

Harvest Cuttings - Mixed Conifers

1. Field division Forest Management Research - Pine Region.
2. Work project Silviculture.
3. Line project Harvest cuttings - mixed conifers.
4. Purpose To discover methods to convert virgin timber into managed forests.
5. Review of past work Between 1910 and 1938, 41 groups of permanent plots, totaling 801 acres, established in merchantable types, sites I-IV, representing 7 methods of cutting. Each tree identified. Measurements at 5 to 10 year intervals for growth and loss. Seed crops recorded by cone counts and traps on 9 areas since 1926. Seedling incidence and growth recorded 422 chains transects, 1884 quadrats, 1911 to 1938. Logging and slash disposal damage studies made. Woods and mill studies in SP-WF type, 1929; in PP type, 1937 and 1939, in cooperation Division of Products. Insect control in PP attempted since 1937 in cooperation Bureau of Entomology and Plant Quarantine. Swain Mountain Experimental Forest, 6080 acres WF-RF, approved 3/22/32; Feather River, 3970 acres mixed conifers, 6/27/33; Blacks Mountain, 10,252 acres PP, 1/28/34. Road systems completed at Feather River and Blacks Mountain. Coordinated studies of management and silviculture adapted to sustained yield begun at Blacks Mountain in 1933 and experimental cutting extended to 1363 acres.

Results currently incorporated into Region 5 marking rules and sale regulations. Results used in Capper Report 1921; Capper Revision, 1932; Copeland Report, 1932; Public Domain Report, 1932; Lumber Code, 1934; and other publications as follows:

1922. Dunning, D. Relation of crown size and character to rate of growth and response to cutting in western yellow pine. Jour. For. 20:4. 379-389.

1923. Dunning, D. Some results of cutting in the Sierra forests of California. U.S.D.A. Dept. Bul. 1176: 27 p.

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1928. Dunning, D. A tree classification for the selection forests of the Sierra Nevada. Jour. Agr. Res. 36:9. 755-771.

1933. Brundage, M. R., M. E. Krueger, and D. Dunning. The economic significance of tree size in western Sierra lumbering. Calif. Agr. Exp. Sta. Bul. 549: 61 p.

1938. Hasel, A. A. Sampling error in timber surveys. Jour. Agr. Res. 57:10. 713-736.

6. Accomplishments At Blacks Mountain experimental cutting
during past year extended by 550 acres with scale of 2971 M
b.m. Insect loss inventory repeated by
Bureau of Entomology and Plant Quarantine. Operating cost and mill
recovery studies continued under direction of Division of Products.
Further report on Le Tourneau log loader prepared.

Methods of cutting study third annual block of six treatments established at Blacks Mountain in ponderosa pine. Re-measured 133 acres of permanent plots in sugar pine - fir. Method of sampling prepared for administrative determination of changes on sale areas resulting from modified marking.

Report prepared proposing experimental withdrawals in sugar pine types at Stanislaus Branch.

7. Plans for next year Continue salvage - insect control cutting, insect loss surveys, cost and recovery, and methods of cutting studies at Blacks Mountain. Continue preparation of publications on natural reproduction in mixed stands and growth prediction in selection stands.
8. Date of completion Indefinite.
9. Assignment Dunning, Hasel, Clements, Drew, Fowells.

RS-CAL
SILVICULTURE
Stand Improvement

January 1940

Stand Improvement

- | | |
|--------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. <u>Field division</u> | Forest Management Research - Pine Region. |
| 2. <u>Work Project</u> | Silviculture. |
| 3. <u>Line Project</u> | Stand improvement. |
| 4. <u>Purpose</u> | To determine suitable methods for thinning and release cutting in young stands of mixed conifers. |
| 5. <u>Review of past work</u> | Between 1912 and 1934, 48 plots established in even-aged pure and mixed stands and in irregular mixed stands. Instructions for stand improvement prepared in cooperation with Region 5. Plots reexamined at 5-year intervals. Analysis of data deferred. |
| 6. <u>Accomplishments during past year</u> | None. |
| 7. <u>Plans for next year</u> | None. |
| 8. <u>Date of completion</u> | Indefinite. |
| 9. <u>Assignment</u> | Dunning, Hasel, Clements. |

RS-CAL
SILVICULTURE
Silvics

January 1940

Silvics

1. Field division Forest Management Research - Pine Region.
2. Work project Silviculture.
3. Line project Silvics.
4. Purpose To determine important physical and biotic factors affecting natural and artificial regeneration.
5. Review of past work Occurrence of seedlings recorded since 1911. Root behavior studied since 1927. Brush invasion after logging charted. Site factors, seed germination, and seedling behavior records since 1931. Cone production records since 1926. Seasonal march of radial and height growth recorded at several altitudes for important species. Effects of planting site preparation on availability of soil moisture determined 1937 to 1939.
6. Accomplishments during past year Maintenance existing studies.
7. Plans for next year Continue site factor, root, and seed crop studies. Prepare report on seasonal growth study.
8. Date of completion Site factor records about 1945. Root and seed crop studies indefinite. Seasonal growth, 1940.
9. Assignment Dunning, Fowells.

January 1940

Stand Studies

1. Field division Forest Management Research - Pine Region.
2. Work project Mensuration.
3. Line project Stand studies.
4. Purpose To provide means of predicting yields.
5. Review of past work Between 1912 and 1934 about 722 plots measured in even-aged stands by Region 5 and this Station, and yield tables prepared for pure stands of WF, RF, DF, and PP and for mixed stands by Region 5, the University of California, the Pacific Northwest Forest Experiment Station, and this Station. A stand density index for even-aged stands published in 1933.

From 541 acres of permanent plots in mixed all-aged stands measured 1911 to 1930, alinement charts prepared for predicting growth and loss in mixed selection stands.

6. Accomplishments during past year Alinement charts for yield predictions in mixed selection stands completed. Sampling methods for required variables reported; application to sale inventories worked out. Preparation of publication continued.
7. Plans for next year Complete publication for yields in mixed selection stands.
8. Date of completion Revisions and improvements will be continued indefinitely.
9. Assignment Dunning, Clements, Hasel.

January 1940

Statistical Methods

- | | |
|--------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. <u>Field division</u> | Forest Management Research - Pine Region. |
| 2. <u>Work project</u> | Mensuration. |
| 3. <u>Line Project</u> | Statistical methods. |
| 4. <u>Purpose</u> | To improve methods of cruising and other types of sampling. |
| 5. <u>Review of past work</u> | Cruising for volume studied for 5 areas with complete coverage by small units aggregating 11,412 acres and results published in Jour. Agr. Res. November 15, 1938.

Line transect method of sampling vegetation studied from quadrats and plots mapped in methods of cutting study and publication being prepared. |
| 6. <u>Accomplishments during past year</u> | A method of routine cruises for sales prepared in cooperation with Region 5 and publication prepared and reviewed. Compilation for line sampling report continued. |
| 7. <u>Plans for next year</u> | Complete line sampling publication and revise cut-over land cruise paper. |
| 8. <u>Date of completion</u> | Continuing. |
| 9. <u>Assignment</u> | Dunning, Hasel, Clements. |

RS-CAL
MENSURATION
Tree studies

January 1940

Tree Studies

1. Field division Forest Management Research - Pine Region.
2. Work project Mensuration.
3. Line project Tree studies.
4. Purpose To provide an adequate series of volume tables for six commercial species.
5. Review of past work Many thousand tree measurements made between 1905 and 1936 by Region 5, State Board of Forestry, the University of California, and this Station. Of many tables prepared 88 still useful, of which 36 prepared by this Station. Current assistance in checking and application of tables.
6. Accomplishments during past year None.
7. Plans for next year None.
8. Date of completion Checking and revision to continue indefinitely. About 15 modern old growth tables should be prepared.
9. Assignment Dunning, Clements.

January 1940

Planting, Seeding, and Nursery Practices

1. Field division Forest Management Research - Pine Region.
2. Work project Regeneration.
3. Line project Planting, seeding, and nursery practices.
4. Purpose To determine methods of reforesting burns and brushfields on timber sites.
5. Review of past work Practical experiments in direct seeding between 1908 and 1913 mostly unsuccessful. Data on seed collection, storage, sowing and viability accumulated at Converse, Pilgrim Creek, Feather River, and Durbin Nurseries by Region 5 and Research 1911 to date. Technic of planting stock production developed by Region 5 and Research 1911 to 1920. Numerous planting tests made between 1911 and 1920. Results to 1920 reported by S. B. Shaw in U.S.D.A. Circ. 92.

Between 1929 and 1937, 15 seeding and 16 planting experiments on limited scale by Research.

In 1937, experiments begun to compare survival and growth of ponderosa and Jeffrey pine seed-spots and transplants after three types of brush eradication, and effects spraying trees with rabbit poison. Second year results for spring 1937 plantation reported.

In 1938, seed grade and stock grade study and season of planting, method of storage study begun at Feather River.

6. Accomplishments during past year Third season records for 1937 plantations completed and reports partly prepared. First season field records for 1938 experiments made.
7. Plans for next year Reexamine 1937 plantations and prepare reports on third year results. Report first season results for 1938 studies and continue transplant phase of seed and stock grade study. Begin I.U.F.E.S.', cooperative Scots pine provenance study. Continue tests of criteria for grading planting stock. Maintain production of experimental planting stock at Feather River Nursery.
8. Date of completion Continuing short-term studies.
9. Assignment Dunning, Fowells, Morrow.

January 1940

Wildlife in Relation to Pine Regeneration
(A cooperative study with the Bureau of Biological Survey,
Department of the Interior)

1. Field division Forest-Wildlife Research.
2. Work project Forest management.
3. Line project Wildlife in relation to pine regeneration.
4. Purpose To determine:

1. Influence of wildlife on regeneration of pine by natural and artificial means on cut-over, burns, brushfields, and stripped brushfields.

2. Effect of cutting and burning on animal life.

3. Extent, direction, and rate of reinvasion of birds and mammals on to or migration from cut-over or burned areas.

4. Effect of succession and development on animal life.

5. Effect of burning of brushfields on rabbit damage to pine transplants planted after the burn.

6. Changes in animal interrelationships on cut-over, burned and brushfield areas.

5. Review of past work Preference of rodents for various seeds determined. Rabbit damage to pine transplants far greater on stripped green brush than on stripped burned area. Clipping of transplants on some green stripped areas is severe. A series of seedlings staked and followed for period of years to determine effect of rabbit clipping upon rate of growth and survival. Rabbit populations fluctuate and this could be taken advantage of if planting program is sufficiently flexible. Severe fire on old established brushfields does not eliminate all seed-eating rodents. Repellent substances tried, of no value in protecting seeds from rodent attack. Stratified seed of value.

6. Accomplishments during past year Only a limited time could be devoted to this study. Continued checks of pine transplants and of rabbit populations. Working up 5 years' data on rabbit-clipped trees. Trial made of additional repellent substances without success. Resident biologist needed.

7. Plans for next year Complete analysis of existing data and prepare report to date. Follow established plots to determine total effect of rabbit clipping. If possible, intensify work on rabbit population and distribution study.

While there was less active field work done on this project during the year covered by this report, it is planned to intensify all phases of this wildlife-regenerative study in cooperation with both the Region and the Station.

8. Assignment E. E. Horn, Biological Survey.

RS-CAL
SILVICULTURE
Harvest cuttings
Redwood

January 1940

Harvest Cuttings - Natural Regeneration and Yield
as Affected by Cutting Methods and Slash Disposal

1. Field division Forest Management Research - Redwood Region.
2. Work project Silviculture.
3. Line project Harvest cuttings - natural regeneration, yield, cutting methods and slash disposal.
4. Purpose To determine the best methods for converting virgin redwood stands to managed stands which will provide maximum sustained yield.
5. Review of past work It has been demonstrated that natural reproduction is most readily obtained on selectively cut areas; that steam logging (particularly with slackline) and broadcast burning are destructive of the currently unmerchantable part of the stand, including trees 30 or more inches in diameter, and create conditions unfavorable for regeneration, either artificial or natural; that small flexible yarding equipment (such as tractors) are best adapted to selective logging and are more efficient than steam under most redwood conditions, and that slash on selectively logged areas can be largely disposed of by controlled burning without serious crown damage to residual trees. Basal damage can be greatly reduced by preventing slash accumulation about residual trees during logging. Henry Creek study indicates minimum economic diameter limit of 36 to 40 inches, leaving reserve of 30 M to 40 M per acre, natural regeneration generally adequate but heaviest following medium to heavy slash burn. Mendocino County logging studies show sharp rise in costs for felling, peeling and yarding with decrease in tree diameter below 36 inches. Bucking and transportation costs little affected by tree diameter.
6. Accomplishments during past year Progress made toward completion of manuscript. "Possibilities in the regeneration of redwood cut-over lands". Short article prepared on Henry Creek natural reproduction study following fourth examination of quadrats. Results of Mendocino County logging studies with index curves for all items from felling to pond made available in research notes. A new study, increment of residual redwoods, was begun with the taking of 1000 cores from 400 redwoods which had been left after logging from 10 to 50 years ago. A problem analysis for silvicultural investigations in the redwood region and a report on the proposed northern redwood experimental forest were submitted.

7. Plans for next year Completion of manuscript covering extensive study of natural reproduction on redwood cut-over lands. Reexamination of natural reproduction quadrats and determination of 1935-40 increment of residual trees on Henry Creek area. Analysis of data obtained from cores taken from residual redwoods on other areas. Cooperation with Products on redwood logging and milling study if arrangements can be completed. Arcata thinning plots will be remeasured.
8. Date of completion Indefinite.
9. Assignment Person, Hallin.

RS-CAL
MENSURATION
Tree studies
Volume tables-Redwood

January 1940

Tree Studies - Redwood and Port Orford Cedar
Volume and Taper Tables

1. Field division Forest Management Research - Redwood Region.
2. Work project Mensuration.
3. Line project Tree studies - redwood and Port Orford cedar volume and taper tables.
4. Purpose Investigation of volume and form of redwood.
5. Review of past work Study of available redwood taper and volume tables, and of methods of constructing volume tables applicable to redwood trees begun in 1935. Detailed measurements taken on 700 redwoods in connection with logging studies, 1935-1938. Preliminary redwood tables prepared for determining volumes for 5 top diameter-basal diameter ratios; 50, 60, 70, 80, and 90 percent of diameter i.b. at 20 feet above base. Schumacher logarithmic method used in preparing equations.
6. Accomplishments during past year Redwood top diameter-basal diameter ratio tables completed and checked against measurements from 150 trees from outlying areas. Preliminary Port Orford cedar volume and taper tables, for use in northwestern California, completed. Based on measurements from 80 trees.
7. Plans for next year Redwood taper tables will be prepared from available measurements from about 1000 trees, for use in logging and milling studies and appraisal work. Field check of Port Orford cedar tables will be made if possible.
8. Date of completion. About 1942.
9. Assignment Hallin.

RS-CAL
REGENERATION
Planting
Redwood

January 1940

Planting - Establishment and Growth of Planted Redwood

1. Field division Forest Management Research - Redwood Region.
2. Work project Regeneration.
3. Line project Planting - establishment and growth of planted redwood.
4. Purpose To study methods and results of planting redwood and associated species.
5. Review of past work Results of commercial planting on 26,400 acres redwood cut-over show average early survival of 36 percent varied widely with exposure, interval between logging and planting, and associated vegetation. Poor survival and growth, especially on southerly exposures, due to severe exposure on clear-cut, severely burned areas. Recent damage and growth studies based on data from 1300 trees on 96 plots show sustained loss of planted trees principally from fire and rodents. Average growth for 10 to 15-year-old trees .54 feet per year.
6. Accomplishments during past year Preliminary analysis of data from the 1937 and 1938 measurements completed.
7. Plans for next year Reexamination of sample plots, statistical analysis of data, and preparation of progress report on growth and damage study.
8. Date of completion Indefinite.
9. Assignment Person.

RS-CAL.
FIRE
Behavior
Forest fuels

January 1940

Behavior - Forest Fuels

1. Field division Forest Management Research.
2. Work project Forest fire protection.
3. Line project Behavior - forest fuels.
4. Purpose To isolate, measure, and determine the manner in which variable physical characteristics of forest fuels influence rate of spread of fire. Immediate objective to provide experimental measures for use in other behavior studies. Ultimate objective to provide basis for sound fuel type classification.
5. Review of past work Set up in 1935 as exploratory project to determine which measures of fuel arrangement best expressed the influence of fuel variation on rate of spread in ponderosa pine and other needle litter fuels. Laboratory scale studies indicated expression of ratio of volume of air space in the fuel bed to surface area of the fuel the best measure of distribution in still air. Preliminary investigation of influence of fuel size employed ponderosa pine sticks 1/28 to 1/4-inch square. Heat values of a number of common fuels tested.
6. Accomplishments during past year Six by six foot wind tunnel employed to determine whether selected measures of fuel distribution remain valid under ranges of fuel moisture and wind velocity encountered in practice. Preliminary analysis indicates validity in ponderosa pine needle litter.
7. Plans for next year Extension of wind tunnel study to other selected types of fuel to test validity of present measures to fuels of different sizes, shapes, and distributions.
8. Date of completion Indefinite.
9. Assignment Buck, Bruce, Blanchard.

RS-CAL
FIRE
Behavior
Fuel moisture content

January 1940

Behavior - Fuel Moisture Content

1. Field division Forest Management Research.
2. Work project Forest fire protection.
3. Line project Behavior - fuel moisture content.
4. Purpose To determine methods of sampling and measuring moisture contents of litter and green fuels, the causes of their variations and correlation with weather, insolation and other factors.
5. Review of past work Study of sampling and moisture determination methods for ponderosa pine litter and northern Californian brush fuels started in 1935. Satisfactory sampling and determination methods developed. Study of seasonal variations in brush undertaken 1937.
6. Accomplishments during past year Study of seasonal variations in brush foliage volume and moisture content completed. Significant variations in both found to occur during seven month season from April to November. Work begun on weather-fuel moisture relationships in ponderosa pine type, consisting mainly of development of measuring and recording methods.
7. Plans for next year Continue weather-fuel moisture study in ponderosa pine, with special emphasis on influence of crown characteristics.
8. Date of completion Continuing with extension to other fuels.
9. Assignment Buck.

RS-CAL
FIRE
Behavior
Ignition of forest fuels

January 1940

Behavior - Forest Fire Ignition

1. Field division Forest Management Research.
2. Work project Forest fire protection.
3. Line project Behavior - forest fire ignition.
4. Purpose To determine the combined influences of wind velocity, moisture content, relative humidity and temperature upon the relative probability of fires starting in specified fuels by given firebrands.
5. Review of past work New project in 1939. Work at other Stations has defined the approximate moisture content which limit the possibility of fires starting from different firebrands, but little is known of the ease of ignition within the range of the limiting conditions.
6. Accomplishments during past year Work during 1939 confined to development of experimental methods for exposing fuels, administering firebrands and measuring the other variables.
7. Plans for next year Complete development of experimental methods.
8. Date of completion 1942.
9. Assignment Buck, Blanchard.

RS-CAL
FIRE
Behavior
Rate of spread

January 1940

Behavior - Brush Test Fires

1. Field division Forest Management Research.
2. Work project Forest fire protection.
3. Line project Behavior - brush test fires.
4. Purpose To determine the influences of wind velocity and fuel moisture content upon rate of spread in the northern California brush type.
5. Review of past work Thirty-three fires burned and results analyzed. Found the additional factors of fuel arrangement and relationship of green to dead fuel in need of measurement before satisfactory correlation possible. Project held up until methods of measuring fuel factor are developed.
6. Accomplishments No fires studied in 1939.
during past year.
7. Plans for next year Small number of fires to be studied to test fuel measures adopted.
8. Date of completion Continuing.
9. Assignment Buck, Blanchard.

RS-CAL
FIRE
Control
Firebreaks

January 1940

Control - Firebreaks

1. Field division Forest Management Research.
2. Work project Forest fire protection.
3. Line project Control - firebreaks.
4. Purpose To determine the effectiveness of firebreaks under California conditions with particular reference to the southern group of forests.
5. Review of past work A study of firebreak effectiveness made by Cecil reported in 1935. Studies of maintenance through stump eradication and soil sterilization included in "Chemical control of vegetation", in this report.
6. Accomplishments during past year Work during the past year was confined to field observations on going fires and analysis of past fire history.
7. Plans for next year. The study is to be continued during the coming year on a more intensive basis. Study of individual past fires will be made on the ground as well as from recorded information, with special emphasis upon large fire patterns as influenced by cover, topography, and wind in relation to existing firebreak patterns.
8. Date of completion Indefinite.
9. Assignment Abell.

RS-CAL
FIRE
Control
Fire danger rating

January 1940

Control - Fire Danger Rating

1. Field division Forest Management Research.
2. Work project Forest fire protection.
3. Line project Control - fire danger rating.
4. Purpose To develop for Region 5 methods of measuring day-to-day fluctuations in the variables influencing fire behavior and of correlating these measurements into an expression of current fire danger. The ultimate purpose of fire danger rating is to permit more effective organization for fire control activities on the national forests and other protected areas.
5. Review of past work Fire danger rating was first undertaken in California in 1937. That year a tentative system based on local research in fire behavior and fire danger rating experience in other regions was placed in operation on four forests. The following year the system was slightly modified and extended to eight additional forests.
6. Accomplishments during past year The rating system was thoroughly revised early in 1939 in accordance with experience and analysis of records of the past two years. The system was extended to all Region 5 forests.
7. Plans for next year The Experiment Station is doing no fire danger rating work during the current winter but will resume active participation in July 1940 with analysis of results to that date. No revisions are planned in the system this year.
8. Date of completion Continuing until such time as a fully satisfactory system has been developed.
9. Assignment Blanchard.

RS-CAL
FIRE
Control
Fire Suppression

January 1940

Control - Suppression Methods and Equipment

1. Field division Forest Management Research.
2. Work project Forest fire protection.
3. Line project Control - suppression methods and equipment.
4. Purpose Improvement of fire suppression methods and equipment used in the California Region. Specific study is being made of organization for large fires, development of fire fighting equipment and evaluation of resistance to control by cover types.
5. Review of past work In 1933 a power driven motor saw was developed for clearing fire line. It has undergone several subsequent modifications. Since 1936 an experimental organization for the suppression of large fires has been in process of development on the Shasta Experimental Forest. In 1937 a study of rate of line construction was begun on the Shasta Experimental Forest through controlled experiments in 5 common types. The following year the study was extended to all California national forests in cooperation with the administrative organization. Data from 200 tests were secured.
6. Accomplishments during past year A new model of the brush saw was constructed. The experimental organization for control of large fires continued with some modifications suggested by previous experience. The study of rate of line construction was temporarily discontinued.
7. Plans for next year In 1940 the new model brush saw will be further perfected and given field trials to secure performance data. Experiments in the organization for large fires will be continued.
8. Date of completion Development work on the brush saw to be completed by end 1940. Large fire organization study continuing. Rate of line construction indefinite.
9. Assignment Brush saw - Morrow.
Fire organization - Buck.
Resistance to control - _____.

RS-CAL
FIRE
Control
Hazard Removal

January 1940

Control - Chemical Control of Vegetation

1. Field division Forest Management Research.
2. Work project Forest fire protection.
3. Line project Control - chemical control of vegetation.
4. Purpose To determine effective methods for maintaining firebreaks, rights-of-way, and other improvements in a fireproof condition, particularly through application of chemicals to kill sprouting stumps and to control herbaceous and other surface vegetation.
5. Review of past work Study of control of vegetation by chemicals started in 1934. Practical methods for killing sprouting stumps have developed. Plots for determination of effectiveness of plant poisons in soil sterilization against annuals established on both northern and southern forests, the latter to determine practicability of sterilizing easily erodable soil. Several stump killing and soil sterilization demonstrations established. Mimeographed instructions issued.
6. Accomplishments during past year All plots and demonstration areas re-examined. New plots established at Placerville to ascertain toxic effectiveness of arsenic trioxide in Aiken clay loam. Cooperation given Stanislaus and Shasta National Forests in sterilizing soil on power line and railroad rights-of-way. Our data pooled with University of California data to ascertain influence of soil type upon sterilizing effectiveness of the more promising chemicals.
7. Plans for next year No new experiments contemplated. Established plots to be re-examined. More demonstrations planned on northern California forests, particularly on roadsides and telephone and power rights-of-way.
8. Date of completion Proposed completion in 1942.
9. Assignment Bruce.

RS-CAL
FIRE
Control
Radius of vision

January 1940

Control - Radius of Vision

1. Field division Forest Management Research.
2. Work project Forest fire protection.
3. Line project Control - radius of vision.
4. Purpose To determine and measure the factors affecting the detection time of fires and the factors influencing a dependable detection distance from a fire lookout.
5. Review of past work This study was begun in 1933 with laboratory studies on the influence of direction of illumination on the brightness of a smoke column and with observations on 200 test fires in the ponderosa pine type. The studies indicated that the pertinent factors are: (1) distance, (2) rate of fire spread, (3) atmospheric haze, and (4) direction of the sun. Two papers covering results of these studies have been published.
6. Accomplishments during past year A theoretical physical analysis of the problem has been completed establishing and defining the many variables upon which radius of vision depends. A paper has been submitted for publication: "Visibility of a smoke column", H. D. Bruce, 31 typewritten pages, 6 figures.
7. Plans for next year In view of greater urgency of other problems, no work is contemplated for 1940.
8. Date of completion Indefinite.
9. Assignment Bruce.

RS-CAL
FIRE
Control
Statistics

January 1940

Control - Statistics

1. Field division Forest Management Research.
2. Work project Forest fire protection.
3. Line project Control - statistics.
4. Purpose The objectives of the statistics project are to currently codify all fire report data of California national forests and to conduct current studies of records to show results and trends in fire protection effort.
5. Review of past work Analysis of fire control data for the northern California national forests published by Shaw and Kotok in 1923. Results of numerous subsequent analyses by same authors published as Department circulars and bulletins. All fire report data since 1911 placed on punch cards with that since 1924 recoded and punched on three 80-column cards. Data used primarily in current Regional fire replanning project.
6. Accomplishments during past year During the past year work on this project was confined to analysis of southern California fire report data to form the basis for a problem analysis and development of a formal research program for the southern group of forests; 250 summary tables prepared, each forest being handled separately.
7. Plans for next year California fire report data for 1939 will be coded, punched, and included in current analyses. Analysis of southern California fire report data will be continued through the stage of interpreting the summary tables already completed but revised to include 1939 data.
8. Date of completion Continuing with exception of current coding and punching of fire report data which is to be handled after this year by the Washington Office.
9. Assignment Abell.

January 1940

Arboretum Management

1. Field division Forest Management Research.
2. Work project Forest Genetics.
3. Line project Selection - arboretum management.
4. Purpose Subdivision and allocation of arboretum ground for species, progenies and hybrids; clearing; planting; irrigation and cultivation; protection against insects, disease, fire, snow and wind; labeling; thinning; periodic measurements; location and acquisition of new land as needed.
5. Review of past work First planting done in 1926. Established arboretum trees now cover 33 acres divided into species, hybrid and progeny blocks. Species block contains approximately 95 of world's pine species and varieties. Progeny block contains progenies of about two hundred known parent trees of ponderosa pine, representing numerous climatic and individual strains. Progenies display marked hereditary differences in rate of growth and branching habits. Most arboretum trees have been bearing flowers available for breeding and cytotaxonomic studies.
6. Accomplishments during past year Ten acres at Institute were planted in March with 81 strains of ponderosa pine progeny seedlings 2 years old. Transect plantation areas of about 3 1/2 acres each were cleared, ripped and disked at Lotus (960 feet elevation) near Pyramid Ranger Station, (5700 feet elevation), and at the Institute (2730 feet elevation). Two additional acres were cleared at the Institute for planting of hybrids now in nursery beds.
7. Plans for next year Approximately 5 acres to be planted at each of three transect sites, Lotus, Pyramid and Institute, to test reaction of elevation strains at these low, medium and high altitude stations for ponderosa pine. Some planting of hybrids to be done.
8. Date of completion Continuous project.
9. Assignment Weidman and Berriman.

January 1940

Pollination Technique, Hybridizing and Selfing

1. Field division Forest Management Research.
2. Work project Forest Genetics.
3. Line project Breeding - pollination technique, hybridizing and selfing.
4. Purpose
 - a. To improve the pollination technique.
 - b. To hybridize pines for the production of forms (hybrids and allopolyploids) that will be superior to existing forms and for analytical purposes.
 - c. Selfing to effect recombinations, to obtain homozygous forms, and for analytical purposes.
5. Review of past work
 - a. A technique has been developed for most phases of the work (collecting, extracting, germinating, and applying the pollen and isolating the ovulate flower). The practical effectiveness of some of its features is, as yet, unknown; but since in some respects they resemble, and in others they improve on techniques used effectively in other fields, they are theoretically adequate for their purpose. The results of the 1938 pollinations will shed light on the efficacy of the technique.
 - b. More than 5000 species and varietal crosses, exclusive of reciprocals, are possible in the genus Pinus; 197 such crosses have been attempted, of which 68 represent crosses within relationship groups (about 1200 are possible) and 129 between relationship groups (about 3800 are possible). Most of the crosses (about 145) were made prior to 1931, since which date several important improvements were made in the pollination technique. Consequently, many of the failures are not regarded as conclusive. Preliminary observations indicate that seven crosses were effected prior to 1937. They follow: (1) P. attenuata X P. radiata; (2) P. echinata X P. caribaea; (3) P. echinata X P. taeda; (4) P. ponderosa X P. arizonica; (5) P. jeffreyi X P. ponderosa; (6) P. ponderosa X P. ponderosa var. scopulorum; (7) P. rigida X P. taeda. Crosses (2), (3), (5), and (7) are quite promising so far as vigor and form are concerned. Cross (1), which involves relatively unimportant species is very impressive since the superior vigor of one parent is combined in the hybrid with the frost hardiness of the other. The cross made by Wakeley of the Southern Station and grown at the Institute between P. palustris and P. caribaea is also very impressive.
 - c. Eight species were selfed prior to 1931. Results were not consistent even for different trees of the same species, probably because of defects in the pollination technique.

Some data indicate that selfing reduces percent of set; others show that it reduces germination percent and vigor at the age of 2 and 7 years. Several selfed specimens of P. jeffreyi are on hand. The hybrid P. attenuata X P. radiata was selfed in 1934. The progeny are quite variable.

6. Accomplishments during past year
 - a. Results of tests in sterilizing equipment indicate that the pollen of pines is rendered inviable when subjected for twenty-four hours to a temperature of 70° C.
 - b. Selections from the 1937 nursery (1934 pollinations) were transplanted to the arboretum; seed from the 1937 pollinations were sown; cones from the 1938 pollinations were collected and 16 interspecific hybridization tests were established. Two species hybrids were backcrossed to their seed-parent species.
 - c. Cones from the 1938 pollinations were collected; one species hybrid was selfed and six species were selfed.
7. Plans for next year
 - a. Improve pollination technique, particularly storage of pollen and sterilizing of equipment. Investigate possibility of protecting cones from insect enemies.
 - b. Establish a few species crosses; sow seed from the 1938 pollinations.
 - c. Establish a few small selfing tests in connection with the hybridization work.
8. Date of completion Continuous project with progress and final reports on various phases to be made annually.
9. Assignment Richter, Stockwell, Cumming.

Cytology, Embryology and Polyploidy

1. Field division Forest Management Research.
2. Work project Forest Genetics.
3. Line project Cytology - cytology, embryology and polyploidy.
4. Purpose
 - (a) To study the structure and development of the reproductive tissues of the more important species of Pinus as an aid to breeding new forms and analyzing the behavior of those forms under observation at present.
 - (b) To attempt to upset the cytological and genetical balance of P. ponderosa by chemical and physical treatments, special effort being directed toward the production of forms with a greater than normal chromosome number, as some of these are likely to be desirable new forms that will breed true from seed.
5. Review of past work
 - (a) Preliminary collections have been made, the basic chromosome number of several species has been determined.
 - (b) No work of this kind has been done with Pinus.
6. Accomplishments during past year
 - (a) Fixations of P. ponderosa were made each month during the year. These were prepared and studied and the time of the various stages was charted. This timing is essential in experimentation with pines because flowers are not borne continuously during the blooming period; on the contrary all the flowers of a given species in any one locality are in approximately the same stage of development at one time and any stage occurs only once for a very brief period during the year. If a hybridization program or a program of physical and chemical treatments is to be planned in advance, timing charts are essential as such work must be done at precisely the proper time if success is to be obtained. A paper was published on pre-embryonic selection in the pines.
 - (b) Heat treated catkins produced abnormal pollen, some of which was approximately twice the volume of normal pollen - an indication that the chromosome number was increased. These pollen grains did not germinate, however, indicating that a study of proper dosage is necessary. Cones were heat-treated at the time of fertilization and seeds were secured for planting. Seedlings treated with colchicine by Mirov were analyzed and polyploid tissues were found, but as yet no entire plant with polyploid cells. A paper on this work was published in collaboration with Mirov.

7. Plans for next year (a) Continue program as outlined with minor changes if needed.
- (b) Continue treatments designed to induce chromosomal doubling.
8. Date of completion Continuous.
9. Assignment Stockwell, Mirov, Cumming.

January 1940

Dendrology

1. Field division Forest Management Research.
2. Work project Forest Genetics.
3. Line project Selection - dendrology.
4. Purpose
 - (a) To study and collect propagating material of naturally occurring hybrids and other unusual pines of possible value in the breeding program.
 - (b) To identify and determine the phylogenetic relationship of the trees used in the experimental program.
5. Review of past work
 - (a) Preliminary study of field hybrids; several aberrant forms collected; many contacts made.
 - (b) Preliminary work in assembling data on species characteristics from various references.
6. Accomplishments during past year
 - (a) Located several trees each representing two species crosses, i.e., P. ponderosa X P. jeffreyi and P. jeffreyi X P. coulteri. Pollen collected from the latter cross and used by Righter in the hybridization program.
 - (b) Continued work in assembling and charting data on species characteristics. Published an article on the variation in Digger pine.
7. Plans for next year
 - (a) Continue search for natural hybrids and other unusual or valuable trees.
 - (b) Complete the identification of arboretum trees that are flowering, as this information is badly needed before analyzing species test back data, and in planning the hybridization program. Possible hybrids produced to date will be analyzed and their validity determined.
8. Date of completion Continuous.
9. Assignment Stockwell, Cumming, Righter, Austin.

January 1940

Improvement of Pines by Physiological Means

1. Field division Forest Management Research.
2. Work project Forest Genetics.
3. Line project Physiology - improvement of pines by physiological means.
4. Purpose To assist in physiological phases of the tree-breeding program. The project includes studies of vegetative propagation of pines, hormone content, nutritive investigations and other phases of the physiology of development of forest trees.
5. Review of past work The project was started two years ago. The preliminary work done during the first year included rooting cuttings of five species of pine cuttings, and the initiation of studies in grafting and in mineral nutrition.
6. Accomplishments during past year Experiments with vegetative propagation by grafting were successfully performed with eleven different species of pines, some of them belonging to quite distant taxonomic relationship groups. Growth hormone studies showed a general correlation between hormone content of seedlings and their vigor. These studies were terminated at the end of the year. Nutritional studies showed very low calcium requirement of ponderosa pine seedlings.
7. Plans for next year Vegetative propagation experiments of various kinds will be continued. Nutritional experiments will be continued and partly completed. Growth hormone studies cannot be continued because of the loss of the WPA technician proficient in hormone detection.
8. Date of completion Indefinite.
9. Assignment Mirov.

January 1940

Progeny Tests and Provenience Studies

1. Field division Forest Management Research.
2. Work project Forest Genetics.
3. Line project Selection - progeny tests and provenience studies.
4. Purpose
 - a. To compare the growth rates, climatic adaptability and value of elevational and other strains of ponderosa pine.
 - (b) To discover which individual seed-trees in each strain yield the best progenies and hence are most desirable as seed sources for reforestation.
 - (c) To evaluate the breeding potentialities of individual seed-trees.
 - (d) To develop technics for progeny testing that will have application in various regions.
5. Review of past work Tests utilizing seed from 765 individual seed-trees of ponderosa pine scattered over most of western United States have shown that this major species is composed of various geographical and elevational strains that are germinally distinct. Slow growth has been secured at the Institute in the case of all races originating in either high altitudes or northern latitudes. Within local strains individual trees vary greatly in their ability to produce desirable progeny.
6. Accomplishments during past year The Institute's second major progeny test, sowed in 1937, was outplanted in March in a 10-acre plantation, using a two-dimensional 9x9 quasi-factorial design. Excellent survival has been secured.
7. Plans for next year During the current dormant season, design and set out the three plantations to carry forward the transect studies now under way at three different elevations in El Dorado County. Make special efforts to renew and finish the long-delayed tree location work in this region.
8. Date of completion Long time project with progress reports at the end of the nursery stage and periodically thereafter.
9. Assignment Austin, Liddicoet.

January 1940

Species Tests

1. Field division Forest Management Research.
2. Work project Forest Genetics.
3. Line project Selection - species tests.
4. Purpose
 - a. To determine the relative growth capacity and climatic adaptability at the Institute and vicinity of the pine species of the world and their geographical races.
 - b. By means of a number of paired tests for each species, to compare the subsequent development of seedlings that are vigorous and normal in the nursery.
 - c. To assemble a complete collection of pine species and their geographical races as material for breeding experiments.
5. Review of past work Project is believed to be world's largest collection of pine species and strains. It also includes 35 other species of conifers and 20 species of hardwoods. Trees of first planting now 14 years old and some nearly 50 feet tall. To test cold hardiness and provide later blooming material, a small plantation is located at Freshpond, 1,000 feet higher than the Institute, containing about 40 pine species.
6. Accomplishments during past year Periodic remeasurements of height, diameter and branching. Seed secured of two pine species not heretofore represented in the arboretum, namely, P. pinceana and P. balfouriana; seed of P. spacheca, P. aristata, P. parryana, P. jeffreyi and P. lambertiana secured from new locations, mostly in Mexico.
7. Plans for next year Periodic remeasurements and keep compilations up to date. Acquire seed or planting stock of pine species and strains that are still lacking.
8. Date of completion Continuous project. Progress report when most of the trees have reached age of 10 years.
9. Assignment For reports on plantings to date: Austin. For acquisition of species: Weidman and Stockwell, with the assistance of the entire staff.

January 1940

Effect of Grazing on Surface Run-off and Erosion - Foothill Ranges
(In cooperation with Division of Forest Influences)

1. Field division Range Research.
2. Work project Grazing management.
3. Line project Effect of grazing on surface run-off and erosion.
4. Purpose To determine effect of different intensities of grazing on (1) surface water run-off, and (2) soil erosion. Highly important to know whether, and to what degree, soil erosion is reducing productive capacity of granite soils. In addition, there is increasing demand for data on water production and floods; the run-off data obtained from these plots will also have bearing on these problems.
5. Review of past work Installation consisting of 3 triplicate sets of 1/40-acre plots established in 1934 on San Joaquin Experimental Range. During this period there was no erosion, and surface run-off was less than 1 percent of precipitation, indicating an infiltration capacity of soil under ungrazed forage cover equal to or in excess of the highest rainfall intensities occurring during that period. Surface run-off from these plots should not be confused with total water yield, which would include percolation.

Since March 18, 1938, 3 plots grazed heavily, 3 moderately, and 3 ungrazed as checks. No increase in run-off during remainder of that season. Forage density increased from 48 percent in 1935 to 69 in 1937. Erodium botrys, Bromus mollis, and Festuca megalura accounted for 82 percent of vegetation cover during the 3 years of protection.

6. Accomplishments Grazing of the plots by sheep continued through a second season. Forage density on plots decreased with intensity of use. On March 20, when sheep turned on, total density amounted to 49 percent on heavily used plots, 51 percent on moderately used, and 55 on protected plots. At height of growing season on April 20, near end of grazing period, density on heavily used plots only 14 percent, on moderately used plots 26, and on ungrazed plots 64 percent. Soil of closely grazed plots now almost bare of litter and that of protected plot has litter at least 1/2 inch deep.

Last season comparatively dry, with rainfall amounting to only 12.22 inches, whereas for the previous seasons it amounted to 29.4 inches in 1934-35, 22.65 inches in 1935-36, 22.96 inches in 1936-37, and 32.04 inches in 1937-38. There was no increase in surface run-off from any of the plots.

7. Plans for next year Continue grazing as for last year. Forage, volume-weight, and soil-moisture sampling to be continued, with probable addition of infiltration tests.
8. Date of completion Probably graze the plots at above rates for a period of at least 4 more years.
9. Assignment Talbot, Biswell (Range Division).
Kraebel, Rowe (Influences Division).

January 1940

Handling Livestock; Herd Management - Foothill Ranges
(A cooperative study with the University of California)

1. Field division Range Research.
2. Work project Grazing management; range animal husbandry investigations.
3. Line project Handling livestock; herd management.
4. Purpose To conduct over a long period of time a study of the effect of animals maintained upon natural feed as compared to animals receiving supplements along with the natural vegetation. Also to see how best the natural vegetation cover could be supplemented to supply its deficiencies in order to maintain the breeding herd in a sufficiently high state of nutrition to produce good calf crops, and to decide by actual trial whether or not it was economically possible to turn off finished cattle or to sell as calves, yearlings, or 2-year-old steers and excess heifers as feeders. To study the possibilities and limitations of a breeding-up program on an average group of females subjected to such an environment.
5. Review of past work In the first calf crops dropped since the establishment of two comparable breeding herds, one to receive supplemental aid and the other a control not supplemented, the supplemented herd produced a 9 percent greater calf crop which had a 95 lb. greater average weight at weaning time. During the severe 1937-38 winter 4 cows and 4 calves were lost in the control herd from conditions directly caused by impoverishment, while no such losses occurred in the supplemented herd. Also there were 48 percent retained placentas in the control herd which required treatment as compared to 7 percent in the supplemented herd.

Supplemented weaner steer calves had a 90 lb. average weight advantage over the control group of steers, which were comparable at start, as long yearlings when they were appraised at 1/2 cent per cwt. higher than the control steers as feeders. If sold, net greater return per supplemented steer would have been \$9.25. The supplemented steers were finished, with heavy supplementing upon the range, for slaughter as long 2-year-olds. Their net return above that per control steer was \$9.69. A similar experiment carried out with the supplemented group being sold finished for slaughter as long yearlings brought a net return of \$7.53 per steer over the appraised value of the control group. The control group was carried another year upon the range and then sold as feeders, with an average selling price \$11.28 below that of the supplemented group sold the previous year. An average of about 380 lbs. of cottonseed cake and rolled barley per animal per year has been fed to the supplemented animals.

6. Accomplishments during past year In 1939 the supplemented breeding herd produced a 19 percent larger calf crop, which averaged 69 lbs. heavier at weaning than did the control herd. Again there was a marked difference in numbers of retained placentas, with 52 percent in the control herd as compared to 5 percent in the supplemented herd.

Fish meal and molasses were used as supplements for the supplemented group of weaners and gave results similar to those previously obtained using cottonseed cake and barley. All of the steers and a portion of the heifers of the supplemented group were then finished for slaughter upon the range as long yearlings with continued supplementation of molasses and fish meal. There were insufficient animals upon which conclusions could be drawn, but these animals did not finish satisfactorily for slaughter. The control group is being carried upon the range for another year when they will be sold as long 2-year-old feeders.

7. Plans for next year A continuation of the present studies except that for the next few years the practicability of producing long-yearling feeders shall be investigated. Also an investigation of the use of body measurements in designating body conformation and as an aid in a range breeding program.
8. Date of completion All studies to be continued indefinitely, with possible slight modifications, throughout duration of animal-husbandry studies.

9. Assignment All these cooperative studies technically directed by the Animal Husbandry Division, College of Agriculture, University of California. Dr. G. H. Hart, H. R. Guilbert, and K. A. Wagnon -- all staff members of the College.

January 1940

Utilization Standards, Grazing Capacity, and Season of Use -
Foothill Ranges

1. Field division Range Research.
2. Work project Grazing management.
3. Line project Utilization standards, grazing capacity, and season of use.
4. Purpose Improvement of yardsticks or standards which will enable one to judge degree of use of a range more positively. Determination of acre requirements and satisfactory stocking and best season to graze foothill lands. These things necessary for recognition and definition of allowable use which will maintain satisfactory range conditions.
5. Review of past work Observations and studies made on degrees of use since San Joaquin Experimental Range established in 1935. For last 4 years equal numbers of cattle kept on 3 pairs of pastures of 160, 240, and 320 acres, for approximately 7 months and then removed to other pastures where supplements fed. For the full year of 1937 about 25 acres needed per cow with calf to weaning time, and this resulted in close utilization. About 21 acres was needed in 1938. Many photographs and measurements of forage taken to show what is happening under different degrees of use. More early feed usually produced following moderate utilization the previous year. Measurements in 1938 showed new forage on moderately used areas ready for grazing from 2 to 3 weeks earlier than on closely used areas.
6. Accomplishments during past year Varying rates of stocking continued. About 22 acres per cow with calf to weaning time resulted in close grazing for the year. Nearly 27 acres were needed for moderate use. Varying rates of use as practiced during the last 4 years caused no very definite differences in forage composition or density. (See following table.)

Species	Pasture size	Percent composition by years				
		1935	1936	1937	1938	1939
<u>Erodium</u>	160 A.	36.2	47.8	40.6	14.7	31.3
<u>botrys</u>	240 A.	28.2	36.0	34.9	15.2	24.9
	320 A.	39.0	40.4	31.0	17.6	29.4
<u>Bromus</u>	160 A.	.5	16.3	26.5	15.9	26.3
<u>mollis</u>	240 A.	1.8	23.3	30.5	16.5	25.7
	320 A.	1.8	18.1	32.7	18.0	27.2
<u>Festuca</u>	160 A.	12.9	16.9	14.0	10.1	12.5
<u>megalura</u>	240 A.	13.5	18.0	8.9	9.2	14.3
	320 A.	12.5	16.1	7.3	11.8	12.0
Total	160 A.	42.3	35.0	—	37.7	40.4
forage	240 A.	48.2	33.8	—	39.3	44.2
density	320 A.	38.3	30.0	—	33.2	42.4

Summarizing, annual range grazed for at least 7 months of year and showing close use at the end produced no definite detrimental effects in forage composition or density the following season, during any of 3 years of study. However, utilization resulting in equal closeness during shorter period may yield entirely different results. Moreover, the longer cumulative effect of close grazing is not yet known.

Comparative/^{annual} yields under different intensities of grazing not yet determined

New plots located in December in heavily and moderately used pastures for measurements of comparative yields.

7. Plans for next year Continue study of yardsticks of use. Continue grazing 6 pastures as before. Install enclosures to determine effects of intensity of use on forage production.
8. Date of completion Indefinite. A continuing project.
9. Assignment Talbot, Nelson, Biswell.

January 1940

Species-Survival Testing of New Range Forage Plants - Foothill Ranges

1. Field division Range Research.
2. Work project Artificial revegetation.
3. Line project Species-survival testing of new range forage plants.
4. Purpose To test valuable forage species from various regions and countries for adaptability to foothill conditions -- a step necessary for selecting most promising plants for large-scale testing and improvement of the range.
5. Review of past work Row-survival tests started in the fall of 1934, at the San Joaquin Experimental Range. Total number of species tested or being tested: 147. Tests include seed furnished primarily by Bureau of Plant Industry and secondarily by various other agencies -- Federal, local, and foreign. Effort directed chiefly toward testing annuals and perennial shrubby species, since native plants and soil-moisture conditions indicate that these are best adapted to the area. Subterranean clovers and bur-clovers have shown considerable promise in nursery. Several species planted in range-competition plots in 1936, 1937, and 1938. In these plots rye grass reseeded itself and garden burnet lived through the summer but produced a poor seed crop. None showed exceptional promise in range plots.
6. Accomplishments during past year Forty-two new species or strains added to list of those being tested in forage nursery, bringing total number to 189. Subterranean clover did exceptionally well in nursery again this year and several rows have now been planted out on range. A short article prepared for the California Wool Grower to cover results with this species and to offer suggestions for those wishing to make tests. Several new plots established for use in field testing.

All work prior to July made possible by emergency funds.
7. Plans for next year Continue row-survival testing. Continue and expand competition-plot testing of most promising species. Try phosphate-fertilizer treatments with subterranean clover. Try new strains of rhizobia on subterranean clover.

Plan this preliminary work as a foundation for future expanded cooperative program required for adequate study of the broad problem of reseeding.
8. Date of completion Indefinite.
9. Assignment Talbot, Biswell.

RR-CAL
RANGE PLANTS
Values

January 1940

Forage Values in Relation to Growth Factors - Foothill Ranges

1. Field division Range Research.
2. Work project Range plants.
3. Line project Forage values in relation to growth factors.
4. Purpose To evaluate the forage crop and follow changes in distribution, abundance, vigor, and yield, of plants from year to year as affected by weather conditions, soil, etc. When more is known of effects of climatic factors on the feed, the stockman can better deal with fluctuations in range feed that characterize the annual type.
5. Review of past work Annual inventories of forage composition and yield made at San Joaquin Experimental Range since 1935. Continuous records on climate and periodic records on growth also maintained. Striking fluctuations in forage yield, composition, and period of availability, from year to year, have taken place.
6. Accomplishments during past year Cattle-exclosure data showed air-dry yield of forage this year to be 1,020 lbs. per acre. This compares with 1,662 lbs. in 1935, 1,012 lbs. in 1936, 807 lbs. in 1937, and 1,130 lbs. in 1938. Last year's production comparatively high considering precipitation low. During December, January, and February growth appeared normal under rainfall of 1.28, 2.87 and 2.46 inches, respectively. With this the case, 9.82 inches, or 59 percent, falling during these months of 1935-36 excess or ineffective; in 1936-37, 8.85 inches or 57 percent excess; and in 1937-38, 13.36 inches or 67 percent ineffective. Temperatures during these months very similar during all years. Forage in swales dried nearly month earlier than during 4 previous years and cattle began to lose weight almost correspondingly early. Summer species common during 4 previous seasons very sparse this year. Because of lack of summer annuals, browsing of shrubs heavier than usual during summer.
7. Plans for next year Sample vegetation in all pastures. Take phenological data in each of 6 grazed pastures and in stock exclosures in each pasture. Continue daily climatic records.
8. Date of completion Sampling studies to continue indefinitely, as a highly necessary adjunct to the grazing-capacity experiment. Climatic and phenological records also a continuing project.
9. Assignment Talbot, Biswell.

January 1940

Biology and Ecology of Range Rodents, etc. - Foothill Ranges
(A cooperative study with the Bureau of Biological Survey,
Department of the Interior)

1. Field division Forest-Wildlife Research.
2. Work project Range-wildlife relationships.
3. Line project Biology and ecology of range rodents, and, secondarily, of other wildlife.
4. Purpose To measure the pressure of various rodents on the range and their influence upon composition, density, and succession of plant species, and to study the relation of disease and predation on rodent populations. To develop better methods of census of animal populations and evaluation of pressure. To determine specific points of life history important on this particular study. A knowledge of these interrelationships needed to evaluate the true position of the rodents and other wildlife species on the range.
5. Review of past work Four fenced enclosures established spring of 1935, at San Joaquin Experimental Range, for isolation of (1) ground squirrels, (2) pocket gophers, (3) kangaroo rats, (4) a control area. Nine other small enclosures built over range. Minimum fencing requirements for rodents determined. Forage inventories made on all plots at height of growing season. Clipping of residual vegetation made prior to fall rains. Food habits and preferences of various species determined. Squirrels decreasing in numbers; in 1939 only one-half or two-thirds as numerous as in 1936-37. Cottontails about stationary at 1 per acre. All rattlesnakes on 40 acres marked, food habits studied. Territories occupied and distances traveled recorded. Study of all predators started in 1937; intensified in 1938. Study of food habits of all animals on range under way.
6. Accomplishments Continued all studies on the Experimental Range, during past year with intensification of population studies by additional help and more traps. Squirrels continue to decrease. Kangaroo rats slowly increasing. Cottontail rabbits about the same. Food-habits work intensified. Periodic collection of skats of mammal predators, pellets of hawks and owls, observation of food taken by adults to young hawks and owls in nests. Analysis of skats and pellets made, but no summary of findings made to date of all analyses. Manuscript by Fitch on "Horned Owls" published by Condor. Rough draft of manuscript by Fitch, Glading, and House on Cooper hawks contains part of such data.

Studies of food habits of rattlesnake continued by skat collection and analysis and by forced regurgitation of captured snakes. Movement and activities further determined. Manuscript on studies prepared for publication. Food correlated with other animals present on area.

Forage inventory and clipping of enclosures continued. Marking experiments continued, most reliance placed on toe clipping of rodents.

7. Plans for next year Continue studies as before. Arrangement now complete for the disease-investigations phase of these studies of populations.
8. Date of completion A continuing project.
9. Assignment Biological Survey — E. E. Horn, Henry S. Fitch,
_____ (Resident on disease work).

Experiment Station — Talbot, Biswell (for
vegetation correlation)

January 1940

Life Habits and Management of Valley Quail - Foothill Ranges
(A cooperative interagency study)

1. Field division Range Research.
2. Work project Range-wildlife relationships.
3. Line project Life habits and management of valley quail.
4. Purpose To study general habits and environmental relationships and factors: food, water, cover, predation, disease, and population trends — with special emphasis on nesting cycle. Information necessary for formulating sound wildlife-management plans — especially information bearing on possibilities and limitations of quail management on foothill cattle ranges.
5. Review of past work Plans formulated in 1936. Actual field work started in 1937, at the San Joaquin Experimental Range. A cooperative undertaking between the California Forest and Range Experiment Station and Region 5, U. S. Forest Service; Biological Survey; California Division of Fish and Game; and Division of Zoology, College of Agriculture, University of California.

Censuses reveal population peak of 1 bird to 1.17 acres reached in 1937. Gradual decline in past 2 years to 1 bird to 2.63 acres in 1939.

Winter quail population grouped in coveys fairly uniformly scattered over the Range, followed by break-up of coveys in March, when pairs are found scattered throughout area. Summer drought causes quail to assemble within a convenient cruising radius about watering places. First soaking fall rain causes redispersal to winter territories.

Roosting cover supplied by dense live oaks, and to some extent by other dense shrubs; escape cover supplied by dead brush, tall grass, rocks, live brush; dead fallen brush with screen of grass affords shelter from midday summer heat. A wide variety of cover affords nesting shelter.

Predation on adult quail not considered to be serious. Predators in order of importance to adult birds are Cooper hawk, Pacific horned owl, followed by exceedingly minor predators.

Nesting studies show that less than 20 percent of all nests are successful; ground squirrels take more than 30 percent of the total nests. The 1937 and 1938 nesting studies in close accord as to results. Lack of summer water considered to be a major life-cycle factor.

All birds thus far examined show infestation with Haemoproteus lophortyx, the organism causing "quail malaria."

Ten quail-stomach analyses each month form the basis for a food-habits study correlating food taken by the birds with available foods as revealed by forage-plant inventory. Results show that quail

definitely prefer certain items such as Spanish clover and true clovers, and ignore others such as the leaves of tarweed and turkey mullein which could supply them with summer succulence if taken.

Controlled hunting started on 720 acres of the Range in 1938. Hunters chosen from Madera Fish and Game Protective Association and instructed as to procedure. In 1938, 26.5 percent of quail on hunting area taken by hunters, which together with the crippling loss totaled 37.6 percent. Figures on birds per man hour: 1:4.

Control of ground squirrels resulted in more quail over a 300-acre area than existed elsewhere over the Range.

6. Accomplishments Nesting study checks approximately with 1938 for
 during past year total hatch and percent of nests robbed by ground
 squirrels. Nesting season started about 2 weeks
earlier in 1939 than in previous years.

Early drying of forage and light rainfall of winter of 1938-39 resulted in serious water shortage during summer. An exceedingly low young-to-adult ratio among trapped and collected quail indicates that, although the nesting season was as successful as the last two, survival of young birds was much lower.

New ground-squirrel-control area of 320 acres set up in spring of 1939. This was poisoned with thallium and later with strychnine, to insure complete removal of squirrels. Lack of watering places in poisoned area indicated that this factor was as great in midsummer as any in controlling quail numbers over an area. Fall censuses on poisoned area indicated that more quail were found there than elsewhere over the Range. A general decrease over the locality was noted — the result of disease, water, or other unknown factors.

The hunting experiment was repeated, with shoots spaced at intervals throughout the hunting season. Censuses in January 1939 and in November 1939 revealed that the population over the hunting area not significantly lower than on rest of the Range. Hunting index figures obtained were not reliable measures of quail populations.

7. Plans for next year Continue studying habits and verifying results,
 laying more emphasis on practical management
features of study.
8. Date of completion Indefinite.
9. Assignment Field technician, Glading (financed by Region 5)
 Technical advisory committee, Storer (University
of California), Horn (Biological Survey). General advisory committee
of 10 members representing the Division of Zoology, College of
Agriculture, University of California; California Forest and Range
Experiment Station; Region 5, U. S. Forest Service; Biological Survey;
and California Division of Fish and Game.

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January 1940

Handling Livestock - Pine Ranges

1. Field division Range Research.
2. Work project Grazing management.
3. Line project Handling livestock.
4. Purpose To determine the best livestock control methods for improving utilization of eastside ranges.
5. Review of past work Studies limited to certain phases of the salting and watering problems; conducted at Burgess Spring Experimental Range.

Methods.

The time relationships between salting and watering of cattle in a 537-acre pasture were measured in 1937 to determine if the cattle went to water immediately after salting. Salt was placed 3/4 of a mile from water. Apparatus was developed to record automatically the time cattle salted and watered.

Results.

Average time interval between salting and watering was about 7 1/2 hours — a significantly greater interval than the 20 minutes required for the animals to stroll to water from salt. These results showed that the cattle did not have to water soon after licking salt, and observations showed that there was no undue trailing. Apparently there was no deterrent to placing salt a considerable distance away from water. Considering the excellent gains in weight made by the cattle, detrimental effects on them could hardly be expected.

In addition, the amounts of salt and water consumed were measured during 1936, 1937, and 1938. The average consumption of salt per month by large steers was 2.34 lbs. in 1936 and 2.15 lbs. in 1938; for a mixed herd containing yearlings in 1937, 1.53 lbs. Water consumption was about the same each of the first 2 years, averaging 7.5 gallons per head in 1936 and 7.68 gallons in 1937. It was not measured in 1938.

6. Accomplishments No work carried on in the field. Past data were analyzed. Started preparation of manuscript on the time relationships between salting and watering by cattle.

7. Plans for next year Indefinite — pending completion of eastside problem analysis. Problem is important on eastside and probably will rank high in priority of study. Analysis of livestock distribution problem on several national-forest allotments may be started. Publication, now in rough draft, will be completed.
8. Date of completion Indefinite.
9. Assignment Talbot, Hormay, Bentley.

January 1940

Utilization Standards - Pine Ranges

1. Field division Range Research.
2. Work project Grazing management.
3. Line project Utilization standards.
4. Purpose (a) To determine the maximum degree of utilization under which forage species and forage types can be maintained. (b) To devise simple usable standards for recognizing and determining the degree of use of the range.
5. Review of past work Past work at the Burgess Spring Experimental Range has been aimed primarily at determining the best methods of studying this problem.

Methods.

- (a) No studies have been made on this phase of the problem.
- (b) Several methods were given a trial in measuring forage utilization.

- (1) In 1936, utilization of forage was measured on 827 quadrats at four periods during season.
- (2) In 1938, utilization of pasture by cattle was sampled intensively by transects at end of season.
- (3) In 1937, utilization of pasture was described at end of grazing season and tentative criteria for judging utilization were established.
- (4) In all years, direct observations were made of the cattle grazing, to determine at what time of season utilization should be judged.

Results.

Tentative criteria for judging degree of range use were established in 1937. Those of most significance are: (1) masking by vegetation of low ground objects — pebbles and cobblestones, low rocks, pine cones, slash, cattle droppings, and fresh gopher mounds; (2) abundance of seed stalks of certain plants; and (3) ratio of grazed to ungrazed plants of certain key species. Initial photographs were taken.

Cattle preferences for most species fluctuated during season; often changed abruptly. This indicates that it may be possible to determine degree of use to be expected at end of grazing season by inspecting indicator species at given growth stages, but that period of grazing them must be known and considered. Rapidity with which

lupine was removed by increased number of stock in 1938 points out that degree of stocking must also be considered.

6. Accomplishments
during past year Partial analysis of data gathered to date.
Publication of utilization standards handbook
for range inspection on national forests of
California, by Swift (Experiment Station) and Fausett (Region 5).
7. Plans for next year Completion of data analysis. No field work
planned. Handbook phase discontinued as a
financed study on July 1, 1939.
8. Date of completion Handbook phase completed. Other phases, in-
definite.
9. Assignment Talbot, Hornay, Bentley.

January 1940

Logging vs. Grazing Capacity - Pine Ranges

1. Field division Range Research.
2. Work project Grazing management.
3. Line project Logging vs. grazing capacity.
4. Purpose To determine changes in forage because of logging.
5. Review of past work Past work, at Burgess Spring Experimental Range, has been aimed primarily at determining the best methods of studying this problem.

Methods.

1935 - Laid out and measured number and basal area of ground vegetation by species on 50 quadrats, in advance of logging, on each of six 2 1/2 x 5-chain plots located on a Forest Service timber sale area.

1936 - Logged by Fruit Growers Supply Co. with tractors; slash left scattered on ground unburned.

1937 - Reexamined plots for reduction in ground vegetation.

Results.

Amount of forage (weight) and the changes in forage due to climate as distinct from those due to logging have to be measured for a satisfactory solution of this problem. These measurements were not made in work to date.

The six logged plots showed a 19 percent reduction in palatable forage. This 19 percent represents the forage actually skidded out or covered up, and does not account for the possible increase in growth of the remaining forage — even the first year following cutting — from decreased competition with the trees removed and from a general change in environmental conditions.

Indications on an adjoining area logged 2 years earlier are that reductions in forage are rapidly regained and the forage stand builds up to a greater level than existed before logging due to increased vigor of growth. Initial reductions may not be of great

practical importance even under heavy cutting — in this case about 85 percent. The slash left in place on the ground rendered only 3 percent of the area totally inaccessible to cattle.

It is felt that the findings on these six plots are indicative of what happens under heavy cutting, but more intensive sampling is needed for more representative figures.

6. Accomplishments during past year No work carried on in field. Analysis made of results.
7. Plans for next year Undetermined. Awaiting outcome of problem analysis. Initiation of formal study unlikely because of lack of funds and man power.
8. Date of completion Indefinite.
9. Assignment Talbot, Hormay, Bentley.

January 1940

Grazing vs. Pine Regeneration - Pine Ranges

1. Field division Range Research.
2. Work project Grazing management.
3. Line project Grazing vs. pine regeneration.
4. Purpose To determine the effect of livestock grazing on the regeneration of cut-over lands.
5. Review of past work

Established reproduction (second year of growth to 5 ft. tall)

Dual-use range (unlogged) Blacks Mountain Experimental Forest,
Lassen National Forest.

Survey 1933, 3,290 acres, 2,168 trees.

Results - Found less than 2.7 percent of trees had been browsed over a period of years, confined chiefly to bedgrounds, watering places, and stock trails. Range grazed moderately, average conditions.

Cattle range (logged) Burgess Spring Experimental Range,
Lassen National Forest.

Plot studies 1937, 1938 on 537 acres, 269 trees.

Results - One tree killed by cattle trampling in 1937. Range grazed moderately in 1937, heavily 1938.

Cattle range (unlogged) Potter Pasture, Modoc National Forest.

Plot studies 1934, 1938 on two 5x5-meter plots located 1/4 mile from water. 14 trees observed.

Results - Grazing injury in 1934, 32.8 percent of grazable foliage; in 1938, 25.1 percent of grazable foliage - 2 killed. Range grazed heavily.

Sheep range (logged) Clover Valley, Plumas National Forest.

Plot studies 1932 to 1938. Observed 34 trees on 1/2 acre.

Results - No grazing injury, no trees killed by livestock. Range heavily grazed.

Sheep range (unlogged) Badger Well, Modoc National Forest.

Plot studies, observations 1/4, 1/2, 1 and 2 miles from watering place, 1934 and 1938.

Results - 1934, 34 trees observed, none grazed.

1938, 20 " " 4 grazed on 1-mile plots.

Seedlings (first year of growth)

Cattle range (logged) Burgess Spring Experimental Range,
Lassen National Forest.

1936 - 4,147 seedlings observed.	55 or 1.3 percent
	killed by cattle.
1937 - 1,956	48 or 2.4 percent
	killed by cattle.
1938 - 453	18 or 1.0 percent
	killed by cattle.

Of seedlings killed by cattle, 90 percent were by
trampling, 10 percent by grazing.

Grazing moderate 1936 and 1937, heavy in 1938.

Sheep range (logged) Clover Valley, Plumas National Forest.

1931 - 45 seedlings. None injured in spite of heavy
grazing on plots.

Sheep range (unlogged) Halls Flat, Lassen National Forest.

1938, August 1 - 3,379 seedlings observed. 627 or
19 percent killed by grazing and trampling.

1938, Sept. 15 - 1,106 seedlings observed. 30 or
3 percent killed.

Grazing moderate to heavy.

Summarizing: Practically all damage to established reproduction confined to bedgrounds, watering places, stock trails; does not loom as a serious regional situation. Problem of first-year seedlings, particularly with sheep grazing, more obscure; evaluation will entail long-range study under different conditions involved. Problem pointed up and methodology for study advanced.

6. Accomplishments No work carried on in the field. Data were
 during past year analyzed.
7. Plans for next year Preparation of study plan and start of field
 pine regeneration on cut-over lands, with emphasis on seedling phase.
8. Date of completion Indefinite.
9. Assignment Talbot, Hormay, Bentley.

RR-CAL
RANGE PLANTS
Values

January 1940

Forage Crop Values - Pine Ranges

1. Field division Range Research.
2. Work project Range plants.
3. Line project Forage crop values.
4. Purpose To find (a) the best season of use of cut-over pine ranges, and (b) other supporting information on the value and use of the type for grazing by livestock.
5. Review of past work Past work at the Burgess Spring Experimental Range has been aimed primarily at determining the best methods of studying these problems.

Methods.

(a) Cattle were weighed at 2-week intervals to determine the best season of use as reflected by one factor: gains or losses in weight of the animals. Phenological records were made to tie stage of growth of key forage species to trend in gains of cattle.

(b) Total gains of the cattle were used as an expression of the forage value of the type. Direct observations of livestock grazing were made to determine composition of forage eaten by the cattle — week by week.

Results.

(a) Weights taken during the grazing period for 3 years show: (1) The cattle made greatest gains early in the grazing season before the key forage species flowered (average daily gains of more than 4 lbs. per day per cow were made in June); (2) the gains declined steadily from June to September; and (3) the cattle lost weight after the forage matured and dried. The loss was not due to a lack of forage but rather to nutritional deficiencies in it after the middle of September. These data show forage has greatest nutritional value early in season. Early use of the forage is indicated providing it can be maintained under this season of use.

(b) Average weight gains per day for the grazing season by cattle of 1.9 lbs. in 1936, 2.0 lbs. in 1937, and 1.4 lbs. in 1938 indicate the high forage value that cut-over pine land may have.

Festuca idahoensis, Lupinus calcaratus, Sitanion hystrix, Purshia tridentata, and Bromus marginatus made up an estimated 88 percent of the forage consumed in 1937.

6. Accomplishments Obtained weights of cattle in Burgess Spring
 during past year pasture during last 6 weeks of season.
 Verified previous results that nutritional
value of forage declines at end of season. Cattle weight losses
were started 1 or 2 weeks earlier than in previous seasons due to
the extreme drought year.

Records of growth and development were made periodically on
222 individual plants in 6 sites near the work center — 3 in timber,
1 in sage, and 2 in meadow. General phenological observations were
made over all of eastside at opening of grazing season. During this
drought year there was less than average difference in date of range
readiness between meadows and timber. Plant growth was retarded
proportionally more on meadows than on timber; consequently, meadows
suffered most as result of poor year. Practically no seed produced
by forage species.

7. Plans for next year Based on eastside problem analysis with
 Region 5, it is planned to make work plans,
select areas, and construct fences for a study of season of use of
cut-over pine and the sage and meadow types used in conjunction with
it.

8. Date of completion Indefinite.

9. Assignment Talbot, Hormay, Bentley.

January 1940

Conversion - New Log Grading System

1. Field division Forest Products.
2. Work project Timber harvesting and conversion.
3. Line project Conversion - new log grading systems.
 - A. For pine region timber.
 - B. For redwood region timber.
4. Purpose To construct log grading rules for the timber of the respective regions based upon significant criteria visible in the standing tree so sharply and clearly distinguished as to permit the grading to indicate within useably close margins what the log will cut out in lumber grades and values. There have been no recognized log grades in the redwood region. In the pine region under the 3-grade system significant log qualities overlap or are confused in such a way that there is no necessary consistency between the log grade and what it will cut out in lumber grades. A grading which would permit such a correlation would be a great boon to lumbering and forestry.
5. Review of past work The detailed studies of log character and of lumber grades and values cut out of the logs studied in the logging and sawmill studies, early seemed to indicate the possibility of constructing, from the data of those studies, a system of log grades which would meet the above need at least better than the grades now in use. Constant attention therefore paid to this aspect in all subsequent work, making detailed diagrams and descriptions, and taking pictures of thousands of logs, tied in with the records of lumber grades obtained. All pertinent data have been assembled, classified and subjected to special analysis to this end, and log grades built up, tested, improved.
6. Accomplishments during past year Work continued collateral to primary studies furnishing data. Practically all logging and sawmill studies made have contributed data. From the earliest ones the logs are being regraded in accordance with present grades and the grade production recomputed, so as to increase the spread of forest sites represented in the data. Report on log grades for pine region issued July 1939. Redwood data inadequate yet in sites represented, for any formal report.

Log Grading Conference held with other Stations, Regional Offices, Washington Office, Forest Products Laboratory and industry, resulting information of recommended standard log grading for ponderosa to apply over its entire range.

7. Plans for next year Check new standard grades in current studies, regrade Blacks Mountain plots on new basis, and recast data on former studies on new basis in order to put them on a comparable plane. Will continue collection of redwood data for use in formulating redwood log grades.
8. Date of completion Redwood study and partial analysis during 1940.
9. Assignment Ericksen.

January 1940

Logging and Milling Studies in Connection with Silvicultural
Selection Cutting on Blacks Mountain Experimental Forest

1. Field division Forest Products.
2. Work project Timber harvesting and conversion.
3. Line project Logging and milling studies in connection with silvicultural selection cutting on Blacks Mountain Experimental Forest.
4. Purpose Determination of costs and realization from cutting eastside pine, Sites III and IV, according to latest silvicultural standards. Devising new logging practices to reduce damage. Testing new equipment.
5. Review of past work Experimental Forest logging project started 1937. Forest Products cooperated with Pine Management in purchase of new equipment, organizing operation, preparing contract for sale of logs, scaling, log grading, planning procedure, and general supervision. Evaluated 925 individual trees on sample marking plot based on log grades and Fruit Growers Supply Company 1934 study data. Loss in lumber values from insects during last three years was \$20 an acre on the plot. Made special studies of log-loading crane loaned for trial by Le Tourneau, Inc. Prepared detailed report on performance, recommending certain alterations. Reported also on performance of logging trucks and railroad loader, specifying improvements to be made by manufacturer. Mill studies of Blacks Mountain logs, all lumber surfaced, conducted, and appraisals made on basis of log grades.
6. Accomplishments during past year Further woods-cost studies conducted in 1939. Data from 1939 mill study partially compiled; 1800 trees log graded on plots to provide stand structure information. Collected data for constructing taper table applying to stand and compilation practically completed.
7. Plans for next year Studies by Products in connection with various phases of the Blacks Mountain Experimental Forest will continue throughout the first cutting cycle, estimated to take from 12 to 15 years. Mill study will be made next year. Appraisal of cutting systems will be revised on basis of more complete data thus provided.
8. Date of completion Continuing project.
9. Assignment Erickson.

RP-CAL
TIMBER CONVERSION
Logging and milling
Insect-infested tree salvage

January 1940

Conversion - Salvage Cutting of Insect-infested Pine

1. Field division Forest Products.
2. Work project Timber harvesting and conversion.
3. Line project Conversion - salvage cutting of insect-infested timber.
4. Purpose Determination of lumber values recovered from ponderosa and Jeffrey pine bug-trees with relation to kind of infestation and elapsed time since attack.
5. Review of past work Bug-trees spotted and classified as to time of attack and insect species by Bureau of Entomology in 1935 on Fruit Growers Supply Company operation. Sample run of logs scaled and graded at mill by Regional Office personnel. Rough-dry lumber inspected by Division of Forest Products, and data analyzed for value before and after insect infestation. Rapid deterioration from blue stain following larval development leaves little chance for profitable salvage unless harvested immediately after infestation, except for trees attacked by flatheads only. Mimeographed report issued. Further office analyses made. Application made in attack in new way on bug-tree problem at Blacks Mountain Experimental Forest by confining first cut largely to trees appearing most susceptible to infestation.
6. Accomplishments during past year No work of importance.
7. Plans for next year No specific studies scheduled. As further studies are needed in connection with insect control work, Products should plan to cooperate in them with other interested organizations.
8. Date of completion Continuing.
9. Assignment Erickson.

RP-CAL
TIMBER CONVERSION
Logging and milling
Pine region

January 1940

Conversion - Depreciation in Seasoning
Surfacing and Handling Lumber, Pine Region

1. Field division Forest Products.
2. Work project Timber harvesting and conversion.
3. Line project Conversion - Depreciation in seasoning, surfacing and handling lumber, pine region.
4. Purpose To compile and present in systematic form the data on effects of such depreciation, grade by grade, upon the lumber produced and upon its value, as shown by the analyses made in the logging and sawmill studies conducted by this Station, and in convenient form for all work agencies. It has largely been assumed in studies conducted elsewhere that a blanket deprecate percent could be applied for these factors. Our studies show that this assumption is erroneous and that the error is of sufficient magnitude that it may entirely invalidate conclusions reached.
5. Review of past work Detailed data on depreciation due to the operations named have been taken in all the logging and sawmill studies conducted by this Station, under the fear that a blanket percentage depreciation allowance was fallacious. Analysis has verified this fear.
6. Accomplishments during past year Data secured covering these phases in 1939 Blacks Mountain study. Analysis under way.
7. Plans for next year Complete and incorporate data and analyses from remaining studies and compile and issue results in analytic form for use of Station and Regional Office and information of other Stations. Secure similar data on studies conducted during year.
8. Date of completion Data on 1939 study, June 1, 1940.
9. Assignment Erickson.

January 1940

Logging and Milling Studies
in California Pine Region

1. Field Division Forest Products.
2. Work Project Timber harvesting and conversion.
3. Line Project Logging and milling studies in California pine region.
4. Purpose Determination of logging and milling costs for different species in pine region, different sizes, classes and values of logs and trees on different timber sites, and returns under different cutting systems. To provide data for preparing log grading rules. To furnish up-to-date data for Forest Service Timber Management and to stimulate better forestry practice on private lands.
5. Review of Past Work Series of studies completed and results reported as bulletins or mimeographed reports.
 - a. Stanislaus study (Pickering Lumber Co. cooperating, 1929) High site I, westside. Results published as Bul. 549 by Cal. Agr. Exp. Sta. 1933.
 - b. Fruit Growers Supply Co. 1931. Special study of white fir milling and seasoning degrade. Office report. Forest Service scaling practice changed.
 - c. Clover Valley Lumber Co. 1932-33. Special study of white fir. Office reports.
 - d. Fruit Growers Supply Co. 1934. Logging, milling and seasoning degrade. East side Sites III and IV. Established that 46-inch trees gave highest net return, larger trees deteriorated in quality, and trees under 20 inches were submarginal in value. As a result of study, cooperating company changed marking practice, leaving more trees of smaller sizes, up to 26 inches. Data used in evaluating over 1,000 trees on Blacks Mountain Experimental Forest sample marking plot. Also in preparing Part II of Manual. Study and report made in connection with field work on Dow power felling saw. Progress reports for Regional Office of Timber Management, Western Pine Association and lumbermen.
 - e. McCloud River Lumber Co. 1935. Intensive valuation study on 100 selected small trees, usually poorly represented in virgin stands, site II. Lumber graded green, rough dry, and surfaced. Showed significant differences in degrade by log and tree classes, and need for extending studies to include dry surfaced lumber depreciation losses, to show true intrinsic values of various tree classes. Mimeographed report issued.

f. Meadow Valley Study - 1937-38. Undertaken at request of R. O. Division of Timber Management to furnish data on westside types 2 and 3. Company cooperation poor, necessitating extra work in field and office. Study contributed to fund of data on sites noted and valuable in setting up new log grades.

g. Consolidation and compilation of data from all studies, east-side and westside, into form most useful to forest administration.

6. Accomplishments Fruit Growers Supply Co. (1934) and Meadow
 during past year Valley study data were all abstracted and
 classified in the several ways required for
analysis, analysis completed, and results incorporated in office
report on Log Grading Classification issued July 1939.
7. Plans for next year Conduct study in second-growth westside pine
 region in cooperation with R.O. and Station
Division of Economics to provide needed information leading to better
silvicultural practice and data needed by Forest Survey related to
tree values for inventory work.

If recommended standard log grades for ponderosa pine are accepted, data from above studies will be reanalysed on basis of standard grades.

8. Date of Completion 1940.
9. Assignment Ericksen.

January 1940

Conversion - Logging and Milling
Manual of Field and Office Procedure
for Logging and Sawmill Studies

1. Field division Forest Products.
2. Work project Timber harvesting and conversion.
3. Line project Conversion - logging and milling. Manual of field and office procedure for logging and sawmill studies.
4. Purpose Principally to inform California operators of simple procedures adapted to making logging and milling studies and in analyzing the data therefrom so that they may be encouraged to conduct studies of their own. Secondly for the information of students or others interested in the details of investigative methods thus far employed in evaluating logs, trees, cutting systems, etc. Many different analytical processes have been used by different workers. Comparisons of which show appreciable differences in results from same field data. Evolution still active in this methodology but California lumber operators are urgently asking for guidance now, suited to the California problem, without waiting for definitive, better methods.
5. Review of past work Part I on Field Procedure was published in multilith form December, 1935. Part II, Office Procedure, delayed by questions respecting statistical prorating of load costs to sizes of logs in the load, and by unavoidable work in other lines. Analysis of the carload problem was made by five different methods for comparison.
6. Accomplishments during past year Publication will utilize data from many sources but mainly from Fruit Growers Supply Company study of 1934. Analysis of nearly all data needed is nearing completion. Organization of material completed. Much of text completed and reviewed by Brundage, although somewhat delayed by need for handling by correspondence.

7. Plans for next year Completion of text. Should be issued in multilith form to match Part I, for immediate distribution to lumbermen who have requested it.
8. Date of completion Manuscript should be completed prior to 1940 field season. Project will be completed with distribution of Part II.
9. Assignment _____

RP-CAL
TIMBER CONVERSION
Logging and milling
Redwood region

January 1940

Logging and Milling Studies in the Redwood Region.

1. Field division Forest Products.
2. Work project Timber harvesting and conversion.
3. Line project Logging and milling studies in the redwood region.
4. Purpose To determine the comparative values of lumber yielded by various classes of trees occurring in virgin redwood stands, and the sawmilling costs incident to each class. Data to be coordinated with logging output studies made by Division of Redwood Management for analysis of relation between net income and different degrees of selective cutting. To provide data for formulating redwood log-grading specifications.
5. Review of past work
 - a. Dolbeer & Carson Lumber Company Study, 1935. Green lumber production from 583 redwood logs, chiefly from Henry Creek plot, 79 acres, established by Station and Regional Office to test feasibility of partial cutting in dense virgin stand. Necessary to formulate log grading rules because none have been established for redwood. Mimeographed reports issued 1936 on relative log values. Curved average selling values per M b.m. green lumber from \$20 for 20-inch Grade 3, to \$36 for 90-inch Grade 1 logs (1936 basis).
 - b. Hammond Lumber Company Study, 1936. Green lumber production study on special run of 100 small and medium logs, 18- to 50-inch diameter. To determine merchantability. Station cooperation requested by company. Majority turned out to be merchantable. Office report prepared.
 - c. Division of Redwood Management's data on logging costs combined with data from mill studies mentioned above and mimeographed report issued showing greatest net returns per annum would be realized by cutting only trees 70 inches and larger in diameter, and greatest returns per acre by cutting only trees 40 inches and larger. Margins per M b.m. for stumpage and profit were \$11.23 and \$9.96, respectively. Results presented at Redwood Logging Conference. Further office work in log-grade specifications showed that reliable rules cannot be formulated without more studies.

6. Accomplishments
during past year No work of importance on this project in 1939.
7. Plans for next year Conduct study at suitable locality to provide needed additional information on tree values and for use in building log grades. To include, if possible, depreciation in seasoning.
8. Date of completion Conduct study during 1940. Complete analysis by June 1, 1941.
9. Assignment Ericksen.

January 1940

Conversion - Production and Utilization of White Fir

1. Field division Forest Products.
2. Work project Timber harvesting and conversion.
3. Line project Conversion - production and utilization of white fir lumber.
4. Purpose Determination of facts pertaining to the cutting, sawing, seasoning, primary manufacture, marketing, and present uses of white fir, with special attention to possibilities of improving the returns from the products or of finding new uses, which will overcome the prevailing operating loss on this species.
5. Review of past work Division of Products cooperated with Forest Products Laboratory prior to 1933 in gathering data on white fir manufacture. Government bulletin published under joint authorship February 1934, covering uses, properties, etc. Much prejudice has been engendered by poor manufacture, insufficient seasoning, and improper use. One of main reasons for loss to operators, however, is large amount of defect in white fir trees. Some small mills with low overhead costs have made money on this species, but most large operators leave it standing. In fir types latter practice deteriorates the stand. Douglas fir from Northwest sets retail price in California. Special depreciation studies of white fir made by Products at Fruit Growers Supply Company, Clover Valley Lumber Company and Sugar Pine Lumber Company mills. Small chance now to utilize the species for pulp account high hauling costs if logs taken to tidewater, stream pollution if pulped in mountains.
6. Accomplishments during past year No further studies of white fir by Station in 1939. Private concerns started preservative treatment of white fir with "Chemonite."
7. Plans for next year Situation will be rechecked during coming year in connection with general survey of utilization problems within the Region.
8. Date of completion A continuing intermittent project, mainly in connection with lumbering studies at present.
9. Assignment Ericksen.

January 1940

Experimental Inventory

1. Field division Forest Survey.
2. Work project Survey of forest resources.
3. Line project Experimental inventory.
4. Purpose To develop a plan for conducting a regional timber volume inventory to determine the quantity, kinds, quality, and availability of the standing timber together with the rate of growth and depletion.
5. Review of past work Field work on an experimental line-plot survey of Bidwell Bar Quadrangle (500,000 acres of timber) completed and timber volumes calculated.
6. Accomplishments during past year Preliminary plan for regionwide inventory to be applied initially to Tahoe National Forest partially completed.
7. Plans for next year Complete plan for inventory of Tahoe National Forest area of 2,500,000 acres. Initiate survey if funds for this purpose are made available July 1.
8. Date of completion 1940.
9. Assignment Wieslander, Jensen, Burks, Wilson.

RE-CAL
FOREST SURVEY
Maps

January 1940

Forest Condition Map

1. Field Division Forest Survey.
2. Work project Survey of forest resources.
3. Line project Forest condition map.
4. Purpose To prepare a map supplementing the vegetation type map and regionwide in scope so far as forest and potential forest land are concerned, showing age class and stocking conditions and productivity for growing forest crops.
5. Review of past work
 - a. Field work completed for 19 out of a total of 137 map units.
 - b. Inch-scale blue-line prints with instructions for coloring have been completed for 12 quadrangle units.
 - c. Modified classifications based on aerial photographs developed.
6. Accomplishments during past year Work begun on Tahoe National Forest aerial survey, but suspended July 1 because of reduced personnel.
7. Plans for next year None unless funds permit increased personnel.
8. Date of completion Will be completed simultaneously with the vegetation type map.
9. Assignment Wieslander, Jenson, Burks, Wilson.

RE-CAL
FOREST SURVEY
Maps

January 1940

Ecological Studies

1. Field division Forest Survey.
2. Work project Survey of wild land resources.
3. Line project Ecological studies.
4. Purpose To increase the usefulness of the vegetation type maps for land use planning and other purposes by the analysis and correlation of the distribution of various species and types with climate, soil, and the effect of fire and other land abuse.
5. Review of past work Mainly groundwork data compilation as follows:
 - (a) Southern California: 49 species distribution maps completed. Isohyetal map constructed, geological and fire history maps partially completed.
 - (b) Santa Cruz Mountains region: Vegetation and soils compiled for 23-mile transect, vegetation and forest resource maps completed, fire and lumbering history data collected.
 - (c) Statewide bibliographical research: 16,600 items on lumbering, fires and vegetation.
6. Accomplishments during past year Under (c) above-8800 items abstracted and indexed.
7. Plans for next year Under (b) Santa Cruz: Analyze and prepare paper for publication on results of vegetation-soil transect study, and under (c) Statewide bibliographical research will continue on past basis.
8. Date of completion Indefinite.
9. Assignment Wicslander, Jenson, Wilson.

RE-CAL
FOREST SURVEY
Maps

January 1940

Herbarium

1. Field division Forest Survey.
2. Work project Survey of wild land resources.
3. Line project Herbarium.
4. Purpose To preserve a collection of native plants
(1) for authenticating all plants recorded
on the vegetation maps and sample plots and (2) of value for
taxonomic, genetic, and ecological studies.
5. Review of past work 23,973 specimens determined, mounted, and
catalogued. Technical Note #8 published.
6. Accomplishments 382 specimens determined, mounted, and
during past year catalogued. Two papers (Arctostaphylos and
Helianthemum) prepared; one additional paper
(Arctostaphylos) prepared for publication.
7. Plans for next year Prepare and submit for publication several
identification keys.
8. Date of completion Continuing project for duration of vegetation
type survey.
9. Assignment Wieslander, Jensen, Wilson.

January 1940

Vegetation Type Map

1. Field division Forest Survey.
2. Work project Survey of wild land resources.
3. Line project Vegetation type map.
4. Purpose To prepare a vegetation type map for the wildlands of California and western Nevada as a basis for land use studies and policies; rating fire hazard and planning fire control; and for application of research pertaining to many phases of wildland resource management.
5. Review of past work Extensive data collected in reconnaissance survey begun in 1926 from which statewide natural cover and land use map compiled in 1934. Progress in subsequent intensive mapping of regionwide area of 72 million acres as follows: Field mapping 45 percent, office compilations 36 percent. Map units published 20 (8 percent), in process of publication 4 (2 percent), and submitted for drafting work prior to publication 8 (2.7 percent). Techniques and classifications developed for mapping with aerial photographs in 30-square-mile experimental survey.
6. Accomplishments during past year Field mapping .43 percent and office work 4.5 percent. Map units published 2 (1 percent), submitted for publication 2 (.42 percent). Release #1 published on results of survey for Santa Cruz Mountains region, with two others (western Nevada and Los Angeles and San Bernardino Counties) nearly completed.
7. Plans for next year Continue preparation of type maps and their publication and also preparation of additional releases covering vegetation type phase of the Forest Survey.
8. Date of completion Indefinite; unless personnel is substantially increased, future progress will be exceedingly slow.
9. Assignment Wieslander, Jensen, Burks, Wilson.

RE-CAL
NEW PUBLIC DOMAIN
N. Sierra Nevada Foothills

January 1940

Land-use Studies

(In cooperation with Divisions of Forest Products, Forest Survey and the University of California)

1. Field division Forest Economics.
2. Work project New Public domain.
3. Line project Northern Sierra Nevada foothills. A cooperative project with the Giannini Foundation, University of California.
4. Purpose To determine extent, location and inter-relationships among natural resources; past and present patterns of land use; land use problems, and conflicts among uses; changes in private and social incomes from land use adjustments; and the probable effect of policies designed to improve land utilization.
5. Review of past work Begun in 1933. Field data on natural resources and past and present utilization patterns collected and analyzed.
6. Accomplishments during past year Completion of analysis of data, completion of map series, and partial write-up of data for publication.
7. Plans for next year Completion of write-up of study for publication of bulletin form.
8. Date of completion 1940.
9. Assignment Josephson, in cooperation with Hill (Forest Products), Wieslander (Forest Survey, and David Weeks, Giannini Foundation, University of California.

January 1940

Financial Returns from Second-growth Timber

1. Field division Forest Economics.
2. Work project Private forestry.
3. Line project Financial aspects - income from second-growth timber production.
4. Purpose To determine and evaluate the factors affecting costs and returns for second-growth timber production in the Sierra Nevada foothills.
5. Review of past work Begun in 1938. Data assembled on area of second-growth forest lands, sites, stand volumes and composition, mortality, growth rates, and quality of second-growth lumber. Market outlets, manufacturing practices, lumber and stumpage prices, and production costs determined by field and office studies. A logging and milling study in second-growth timber revealed variations in costs and values by tree diameters. Study of sample property made to determine potential income from selective timber management.
6. Accomplishments during past year Analyses of field data completed. Report prepared and submitted to the University of California in partial fulfillment of the requirements for a doctorate in Agricultural Economics. Revision of report for publication begun.
7. Plans for next year Completion of editing and revision of manuscript, and submission for publication. Preparation of articles, one briefing study, the other expanding section on interest from forest investments. Extension of study to determine costs and incomes for a selected area of second-growth forest land in the northern Sierra foothills.
8. Date of completion 1940.
9. Assignment Josephson.

RE-CAL
STATISTICS
Lumber production, etc.

January 1940

Lumber Census
(In cooperation with U. S. Bureau of the Census.)

1. Field Division Forest Economics.
2. Work project Forest Products statistics.
3. Line project Lumber, etc., census.
4. Purpose To collect, edit, and record for the Bureau
 of the Census data on the production of lumber,
lath, shingles and other forest products; and for the Forest Service,
data on stumpage prices, log prices, and lumber distribution.
5. Review of past work A standardized project of long standing.
6. Accomplishments Canvass made as usual.
 during past year
7. Plans for next year Continue as usual.
8. Date of completion Continuing project.
9. Assignment Miss Gruenewald, with advice and assistance
 of Erickson, Person, and Josephson.

January 1940

Relation of Forest Cover to Streamflow
Bass Lake Run-off and Erosion Plots

1. Field division Forest and Range Influences.
2. Work project Influence of natural vegetation on streamflow.
3. Line project Forest - relation of forest cover to streamflow. (Second-growth ponderosa pine. Bass Lake run-off and erosion plots.)
4. Purpose To study the influences of second-growth ponderosa pine stands on surface run-off and erosion.
5. Review of past work Established in 1934; installation comprised of six 1/40-acre plots, placed in triplicate in 60- to 80-year-old second-growth ponderosa pine stand, near Bass Lake, Sierra National Forest. All plots operated without disturbance of vegetation cover during a 4-year calibration period. On one set of three plots the ground cover of litter and herbaceous vegetation was burned off in the fall of 1938 and again in the fall of 1939 to study the effect of light ground fires on surface run-off and erosion.
6. Accomplishments during past year The 1938-39 season may be characterized by a lack of high intensity rainfall and a total precipitation approximately 48 percent below the average of the preceeding four years. During the 1938-39 season there was a slight but insignificant increase in surface run-off and erosion as a result of the burning. Needle fall from the pines following the burning afforded a fairly good ground cover before the occurrence of the first winter rains.

Intensity rain-gage, one standard rain-gage, and the snow gaging station were moved to a more favorable location, in order that these installations will more nearly conform to Weather Bureau standards.
7. Plans for next year Intensity of snowfall measurements to be increased, otherwise study to be continued without change in procedure.
8. Date of completion Indefinite.
9. Assignment Kraebel, Rowe, Daniel.

January 1940

Relation of Forest Cover to Streamflow
Kings River Branch - Teakettle Creek Unit
Fir-Pine

1. Field division Forest and Range Influences.
2. Work project Influence of natural vegetation on stream-flow.
3. Line project Forest - relation of forest cover to stream-flow. Kings River Branch - Teakettle Creek Unit.
4. Purpose of work To study precipitation, run-off, ground-water, and erosion in relation to topography, geology, soil, vegetation and fauna in mountain areas by means of comparable watersheds typical of the high Sierra region in the San Joaquin Valley.

To determine methods of managing watersheds in representative fir and fir-pine types of the Sierra Nevada (tributary to San Joaquin Valley) for the maximum beneficial yield of water consistent with satisfactory control of floods and erosion and with other legitimate uses of the forest. Precipitation chiefly snow.
5. Review of past work Three 500-acre watersheds were selected in 1934 in the headwaters of Teakettle Creek between elevations 6,000 to 8,000 feet. The area is tributary to North Fork of Kings River, Sierra National Forest, 75 miles from Fresno. Topographic map completed in 1935 and geological study including map and report in 1936. Facilitating improvements completed include 2 gaging stations with dams for erosion measurements, 3 shelter cabins, 1 warehouse, 8 miles roads and 2 miles telephone lines.
6. Accomplishments during past year Partial records started include surveys of two snow courses, intermittent operation of three gaging stations and certain climatic observations. Improvements completed with assistance from WPA were: 1 gaging station with dam and debris reservoir, 25 miles of trails marked with 1500 snow markers and a domestic water system with 30,000 gallon reservoir.
7. Plans for next year Continue collection of data with additional snow observations as personnel permits. Continue construction of minor facilitating improvements.
8. Date of completion Indefinite.
9. Assignment Kraebel, Munson, with supervisory assistance of Sinclair and technical assistance of other staff members as required.

January 1940

Relation of Chaparral Cover to Streamflow
Barranca

1. Field division Forest and Range Influences.
2. Work project Influence of natural vegetation on stream-flow.
3. Line project Chaparral - relation of chaparral cover to streamflow - Barranca.
4. Purpose To develop methods of measuring debris-laden flows and to study rainfall - run-off relationships and the development of chaparral during re-growth after fire.
5. Review of past work A debris-catchment reservoir, streamflow measuring equipment, seven rain gages and 36 milacre quadrats were established on this 44-acre watershed two years after denudation by fire. Weirs, Parshall flumes and tipping bucket installations proved inadequate as means of measuring flashy debris-laden run-off resulting in incomplete records, but erosion deposits have been measured annually in reservoir. See Relation of Forest, Brush and Grassland Cover, State-wide.

Records from annual charting of quadrats indicate that the number of shrubs per acre has decreased from 800 in 1927 to 500 in 1937, with a corresponding decrease in canopy spread per plant from 14 to 13 square feet due primarily to failure of Ceanothus crassifolius. A 3-foot San Dimas flume installed at gaging station furnished a continuous measurement of the debris-laden streamflow which occurred during the flood in March 1938.
6. Accomplishments during past year Quadrats charted, raingages and streamgaging station maintained. For erosion measurements refer Intensive Erosion Measurements and Surveys, State-Wide.
7. Plans for next year Instruments to be maintained and records collected on run-off, erosion, rainfall and vegetation. If personnel permits, past records will be analyzed for a progress report.
8. Date of completion Project to be continued for eight years more.
9. Assignment Kraebel, Sinclair, Storey, Weaver.

RI-CAL
STREAMFLOW
Shrub cover

January 1940

Relation of Chaparral Cover to Streamflow
Berkeley Run-off and Erosion Plots

1. Field division Forest and Range Influences.
2. Work project Influence of natural vegetation on streamflow.
3. Line project Chaparral - relation of chaparral cover to streamflow. (Coast brush type, Berkeley, Strawberry Canyon run-off and erosion plots.)
4. Purpose To study the influence of chaparral vegetation on surface run-off and erosion.
5. Review of past work Installation comprises 3 pairs 1/60-acre plots established 1932. One pair plots maintained with natural vegetation cover, one pair burned periodically, one pair burned annually. Results to date indicate that reestablishment of vegetation is normally so rapid that repeated denudation only slightly increases surface run-off and erosion.
6. Accomplishments during past year Results substantiated those of previous years.
7. Plans for next year Studies to be continued to observe long time effects of annual burning on surface run-off and erosion and to serve as a demonstration unit for visiting scientists and forestry students. Results to be summarized in preparation for publication.
8. Date of completion Indefinite.
9. Assignment Kraebel, Rowe, Daniel.

January 1940

Relation of Chaparral Cover to Streamflow
North Fork Run-off and Erosion Plots

1. Field Division Forest and Range Influences.
2. Work project Influence of natural vegetation on streamflow.
3. Line project Chaparral - relation of chaparral cover to streamflow. (San Joaquin foothills, chaparral woodland brush, North Fork run-off and erosion plots.)
4. Purpose To study the influence of chaparral woodland vegetation on surface run-off and erosion.
5. Review of past work Installation comprises three pairs of 1/40-acre plots established 1929 and two pairs of 1/100-acre plots established 1933. Smaller plots are equipped with a sprinkler system to permit runs employing artificial rainfall. Vegetation on one pair of 1/40-acre plots was burned annually from 1929 to 1938; on a second pair the vegetation was burned in 1930 and again in 1936; and on a third pair the vegetation has been maintained without burning. The 1/100-acre plots were operated during a 3-year calibration period without disturbance of the vegetation. Following the calibration period one pair of the plots have been denuded annually by burning. During the 9-year period between 1929 and 1938 there was approximately 43 inches of surface run-off on the 1/40-acre annually burned plots, 5.6 inches on the twice burned plots, and 0.1 inch on the undisturbed plots. Corresponding erosion rates were 113 tons, 4 tons, and 0.006 ton per acre, respectively. Results of the smaller plot studies employing artificially made rainfall have substantiated those of larger plots.
6. Accomplishments during past year Precipitation for the 1938-39 season was 24.84 inches, approximately 75 percent of normal. Surface run-off from the plots burned annually until the 1938-39 season was 6.8 percent of the total precipitation, from twice burned plots less than 1 percent of the precipitation, and from undisturbed plots only a very small trace. Erosion rates were 3180 pounds per acre, 7.5 pounds, and none, respectively.

On the pair of 1/100-acre plots burned for the first time in 1936, the surface run-off was equal to 2.6 percent of the precipitation and produced erosion at the rate of approximately 1270 pounds per acre. On the pair with an undisturbed vegetation cover there was no surface run-off or erosion recorded during the 1938-39 season.

7. Plans for next year Precipitation, run-off, and erosion measurements on all plots to be continued without change in treatment, and records summarized. Natural rain on the 1/100-acre plots to be supplemented by a series of runs employing artificial rainfall. Results of the first nine years of the study to be submitted for publication in 1940. Records of the 1938-39 and 1939-40 season will be summarized in preparation for analyses by the method developed for use in analyzing the North Fork infiltrometer data.
8. Date of completion Indefinite.
9. Assignment Kraebel, Rowe, Daniel.

January 1940

Relation of Chaparral Cover to Streamflow
San Dimas Experimental Forest

1. Field division Forest and Range Influences.
2. Work project Influence of natural vegetation on streamflow.
3. Line project Chaparral - relation of chaparral cover to streamflow - San Dimas Experimental Forest.
4. Purpose To evaluate the factors of precipitation, streamflow, ground water and erosion and to study their relationship to topography, geology, soil, vegetation and fauna on certain watershed units in southern California.

To determine methods of managing watersheds in typical chaparral forest cover of southern California for the maximum yield of useful water consistent with conservation and satisfactory control of floods and erosion.

5. Review of past work Initiated in 1932. Experimental area embraces 17,000 acres of San Dimas and Big Dalton drainages within the Angeles National Forest tributary to San Gabriel River. Observations being made on 17 watersheds varying from 35 to 10,200 acres each. Installations include: 425 raingages, of which 25 record intensity, 7 meteorological stations, 17 streamgaging stations, and 9 reservoirs for erosion measurements. Two Los Angeles County flood control dams are used cooperatively as controls. Detailed surveys of vegetation, fauna, and geology of the Forest started. Vegetation type map of Bell and Fern watersheds completed and 14 phenological plots established. Forest herbarium includes about 450 species; collection of birds and animals numbers more than 150 species. Detailed geologic surveys of Bell and Fern watersheds completed and geology of Big Dalton drainage mapped. Research activities on Experimental Forest disrupted for several months during 1938 March flood and November fire.
6. Accomplishments during past year All research installations operated. Precipitation data tabulated and summarized to date, streamflow and other data nearly complete to date. San Dimas flume studies were continued at Berkeley in cooperation with University of California, and a standard design adopted for use on Flood Control Surveys.

Publication: "An analysis of precipitation measurements on mountain watersheds," by H. G. Wiln, A. Z. Nelson and H. C. Storey, Monthly Weather Review, June 1939.

Manuscripts: "Topographic influences on precipitation," by H. C. Storey, Sixth Pacific Science Congress, August 1939. "San Dimas streamgaging flume - a code for installation and operation," S. M. Munson, Karl J. Bermel and H. C. Storey, CT&RES Research Note No. 22.

Study of five types of raingages was continued at Tanbark Flat and 3 circular catchment surfaces added to installation. Succession of vegetation on Fern watersheds following 1938 fire was observed in detail. Forest Herbarium enlarged.

Improvements included: (1) Flood control measures on burned area in Fern Canyon involving roads, drainage and channel stabilization partially complete. (2) Forest Service Administration Building in Glendora 80 percent complete. (3) Two streamgaging stations remodeled. (4) Dry Lake Camp reconstructed and other flood and fire rehabilitation work continued.

7. Plans for next year Present research installations to be continued and records summarized. Analysis of streamflow and other records to be made.

Study of several types of raingages to be continued and data analyzed.

Influence of bedload on rating of the San Dimas flume to be studied at Berkeley in cooperation with University of California.

Surveys of watershed areas and physiographic features to be made. Inventories of geology and vegetation to be completed and soils inventory started. Continuation of the studies on the quantitative composition of typical chaparral.

In addition to regular maintenance of facilities, planned improvements include:

1. Flood control measures on burned area in Fern Canyon to be completed.
2. Three large streamgaging stations to be remodeled.
3. Movable bridge at lysimeters.

8. Date of completion Indefinite.

9. Assignment Kracbel, Sinclair, Storey, Hamilton.
San Dimas flume studies - Berkeley:
Munson, Storey.

January 1940

Relation of Chaparral cover to Streamflow - Plot Studies

1. Field division Forest and Range Influences.
2. Work project Influence of natural vegetation on stream-flow.
3. Line project Chaparral - relation of chaparral cover to streamflow.
4. Purpose To study the influence of typical types of chaparral vegetation on surface run-off and erosion.
5. Review of past work
 - a. San Dimas series: (San Dimas Experimental Forest) elevation 1200 feet, old north slope mixed chaparral, 2 pairs 1/40-acre plots established 1930. Vegetation on one pair undisturbed. Second pair burned annually until 1937, unburned since as succession study.
 - b. Tanbark Flat series: (San Dimas Experimental Forest) elevation 2800 feet, ceanothus-oak-chenise subtype unburned for 19 years, 3 triplicate sets 1/40-acre plots established 1934. Vegetation on all plots undisturbed during calibration period.
 - c. Fern Canyon series: (San Dimas Experimental Forest) elevation 5000 feet, oak-woodland subtype 50-year-old chaparral, 3 triplicate sets 1/40-acre plots established 1934. All plots denuded by forest fire November 1938. Plots treated as follows: 3 left untouched as controls; 3 oak stems felled and placed on ground surface at right angles to slope; 3 sown to mustard.
6. Accomplishments during past year Formerly denuded plots of San Dimas series were not burned to continue succession studies. Run-off from Tanbark Flat series during four seasons of record has averaged less than 1 percent of the rainfall with maximum of 2 percent during major storm of March 1938. Run-off and erosion low for season 1938-39.

Marked increase in run-off and erosion recorded from Fern plots after denudation.

All installations operated. Data tabulated and summarized to date.
7. Plans for next year Continue San Dimas series as a succession study. After analysis of data start treatment of vegetation on Tanbark Flat series. Continue operation of Fern series under present treatments.

8. Date of completion Definite date cannot be set for completion of project.
9. Assignment Kraebel, Sinclair, Rowe, Hamilton.

Relation of Woodland Cover to Streamflow
Kings River Branch - Big Creek Unit

1. Field division Forest and Range Influences.
2. Work project Influence of natural vegetation on stream-flow.
3. Line project Woodland - relation of woodland cover to streamflow - Kings River Branch - Big Creek Unit.
4. Purpose To study precipitation, run-off, ground water, and erosion in relation to topography, geology, soil, vegetation and fauna in mountain areas by means of comparable small watersheds typical of the Sierra foothill region in the San Joaquin Valley.

To determine methods of managing watersheds in representative woodland forest type of oak, grass, chaparral and Digger pine in the Sierra foothills for maximum beneficial water yield, consistent with satisfactory control of floods and erosion and with other legitimate uses of the forest.

5. Review of past work Initiated 1934. Major construction completed 1937 on seven small watersheds (elevation range 1,000 to 2,000 feet) embracing 200 acres on tributaries of Big Creek which enters Kings River 45 miles from Fresno. Area grazed annually during April, May and June. Installations include 100 raingages, 3 meteorological stations, 3 rainfall intensity gages, 9 streamgaging stations, 3 reservoirs for extreme and 5 reservoirs for moderate erosion measurements. Improvements include 5 miles trails, headquarters facilities, 6 miles telephone lines and 1 field shelter.

First complete seasonal records obtained during 1936-37 on 3 watershed units (IV, V, and VI) and collection of data at other stations was started as soon as construction completed. Technical Note No. 11, Kings River Branch, Watershed Study Units, prepared by S. M. Munson.

Geological study including map and report completed.

In December 1937 an extreme storm caused extensive damage within the experimental area through boulder flows. Rehabilitation was completed by July 1938 and included the removal of large deposits of debris, structure repairs, and the revision of structures to protect them against similar damage. All landslides occurring during this storm mapped and volumes of earth movement estimated.

A gaging station was established on Big Creek near the experimental area to provide a record of streamflow from an intermediate watershed approximating 70 square miles in area.

6. Accomplishments
during past year Collection of seasonal precipitation, runoff and erosion records continued and records partially analyzed. Soil infiltration studies started.
7. Plans for next year Continue the collection and compilation of precipitation, runoff, erosion and climatic data and their analysis. Continue vegetation surveys and soil infiltration studies and initial soils study with the University of California. A cooperative study with Biological Survey is planned on rodent populations and its relation to erosion and runoff.
8. Date of completion Indefinite.
9. Assignment Kraebel, Munson, with supervisory assistance of Sinclair and technical assistance of other staff members as required.

January 1940

Consumptive Use of Water
by Brush and Chaparral Species
Berkeley

1. Field division Forest and Range Influences.
2. Work project Water utilization by vegetation.
3. Line project Brush and chaparral - consumptive use of water by brush and chaparral species (Berkeley lysimeters, Oxford Street and Strawberry Canyon.)
4. Purpose To study the influence of brush and chaparral vegetation, including litter of various types, on the disposition of precipitation (interception, infiltration, evaporation, transpiration, percolation, and surface run-off.)
5. Review of past work Oxford Lysimeters: Initiated 1927 with series A of eight lysimeters. Two series, B and C, of five tanks each, added in 1931. Series A and C temporarily discontinued in 1936. Series B continued in operation to date. First publication 1930: "Influence of forest litter on run-off, percolation, and erosion," Jour. Forestry 4. Partial results published in Station mimeographed pamphlet, 1935: "Run-off and erosion experiments in mountain areas." Partial results also used in other publications.

Strawberry Canyon Lysimeters: Two series (A and B) of five rectangular lysimeters installed 1931. Each lysimeter is 80 square feet in area by 50 inches deep. Three tanks of series A filled with Altamount soil collected at the site of installation and two filled with a Sierra foothill sandy clay loam collected near North Fork. All five tanks planted to Quercus dumosa in 1933. All five tanks of series B filled with Altamount soil. Planted to Ceanothus cuneatus in 1933. All tanks both series A and B, operated without treatment until June 1938 to allow vegetation to form complete canopy, when vegetation thinnings were started on series B, as follows: Tank 1, vegetation undisturbed, density 60 percent; tank 2, density of vegetation reduced to 51 percent; tank 3, to 41 percent; tank 4, to 19 percent; and tank 5, completely denuded. Density of vegetation on series A not yet sufficient to permit satisfactory manipulation. The season preceding treatment on series B the evaporation-transpiration losses for this series were approximately 4 inches greater and the total percolation approximately 4 inches less than for series A.

6. Accomplishments during past year Oxford Lysimeters: Rainfall for 1938-39 approximately 13 inches. Surface run-off from bared soil tank was 23.7

percent of the total precipitation, from 1/8-inch Monterey pine litter-covered tank 11.9 percent, and from remaining tanks with pine litter covers ranging in depths from 0.5 to 1.5 inches the run-off averaged approximately 4.8 percent of the precipitation. Percolation through bare soil was 13.9 percent of the precipitation, through the 1/8-inch litter covered soil 31.7 percent, and through the soils with deeper litter depths approximately 45.0 percent. Evaporation averaged 62.4 percent, 56.2 percent, 50.2 percent, respectively.

Strawberry Canyon Lysimeters: Rainfall for 1938-39, approximately 16.1 inches. On the oak lysimeters, series A Altamount soil tanks, the average surface run-off, percolation, and evaporation-transpiration was 0.0, 10.2, and 89.8 percent of the total precipitation, respectively; and from the Sierra soil tanks, 0.8, 22.7, and 76.5 percent, respectively. The surface run-off percolation, and evaporation-transpiration from the ceanothus lysimeters, series B, was: Tank 1, with 60 percent average density, 0, 1.8, and 98.2 percent of the total precipitation, respectively; from tank 2, with a 51 percent cover, 0.1, 3.2, and 96.7 percent, respectively; from tank 3, with a 41 percent cover, 0.1, 0.2, and 98.6 percent, respectively; from tank 4, with a 19 percent cover density, 0.0, 10.4, and 89.6 percent, respectively; and from tank 5, with a bare soil, 1.3, 37.6, and 61.1 percent of the total precipitation, respectively. The soil moisture in all tanks at the start of the season was approximately the same.

7. Plans for next year Oxford Lysimeters: The litter series study to be completed and an experiment to determine the effects of mustard sowing on soil water relations, including erosion, to be started. All tanks to be moved to the Gill Nursery tract during the summer of 1940.

Strawberry Canyon Lysimeters: All installations to be continued. Manipulation of vegetation by thinning to be started on oak series as soon as canopy closure is obtained. A progress report including the data through the 1938-39 season to be prepared.

8. Date of completion Indefinite.
9. Assignment Kraebel, Rowe, Daniel, Gleason.

January 1940

Consumptive Use of Water by Brush and Chaparral Species
Devil Canyon and San Dimas

1. Field division Forest and Range Influences.
2. Work project Water utilization by vegetation.
3. Line project Brush and chaparral - consumptive use of water by brush and chaparral species (lysimeter soil moisture, and interception studies).
4. Purpose To study the influence of native chaparral vegetation on the disposition of precipitation (percolation, transpiration, evaporation, interception, and run-off) under controlled conditions.
5. Review of past work

Devil Canyon group. This installation was discontinued in 1936.

San Dimas Experimental Forest group. Installed in 1937 and composed of 26 large concrete lysimeters, each 5 milacres in area and 6 feet deep and equipped to measure the intensity of rainfall, percolation, and run-off. Series also includes 102 circular lysimeters equipped with weighing apparatus. Thirty of these small lysimeters have a soil capacity of 1800 pounds and 72 have a soil capacity of 300 pounds. The San Dimas group also includes 5 unconfined lysimeters, each $17\frac{1}{2}$ feet square by 7 feet deep, located in the vegetation border strips and filled with the same soil as the large lysimeters. Observations on the unconfined lysimeters will be made by soil moisture sampling. Installation completed and collection of data initiated with the beginning of the 1937-1938 rainy season.

Five concrete lysimeters 4 x 6 feet in size and 6 feet deep, having one removable wall installed for study of root development, were completed in 1938. Soil settlement measurements made in large lysimeters, summer 1938. Manuscript: "A lysimeter installation for evaluating the water economy of chaparral" by E. A. Colman and C. J. Kraebel.

6. Accomplishments during past year Soil settlement measurements made in large lysimeters. Record of weekly soil moisture changes obtained for small and medium tanks. Data from all lysimeters summarized to date and analysis started. Conference held with consultants from University of California regarding plans for experiment.

7. Plans for next year Analyses of available data to be completed before changes in procedure are made.
Movable bridge for lysimeters to be redesigned and built.
8. Date of completion Indefinite.
9. Assignment Kraebel, Sinclair, Hamilton, Rowe.

January 1940

Consumptive Use of Water
by Brush and Chaparral Species
North Fork

1. Field division Forest and Range Influences.
2. Work project Water utilization by vegetation.
3. Line project Brush and chaparral - consumptive use of water by brush and chaparral species (North Fork, interception and soil moisture studies).
4. Purpose To study the influence of chaparral-woodland vegetation on the disposition of precipitation.
5. Review of past work Lysimeters: Four rectangular lysimeters installed in 1932, each 1000 sq. in. in area and 20 inches deep and filled with soil collected at site of installation. From 1932 to 1937 two tanks operated with bare soil surfaces and two with a 2-inch ponderosa pine litter cover. In 1937 the litter cover was burned off one tank, a 2-inch ponderosa pine litter was placed on one of the bared soil tanks, and two tanks continued in operation without change in treatment. The litter cover completely prevented erosion and resulted in an 80- to 90-percent reduction in surface run-off and a 20- to 40-percent reduction in surface evaporation.

Four circular lysimeters installed in 1932, each 36 inches deep and filled with soil collected at the site of installation, two tanks each 706 sq. in. and two tanks each 1000 sq. in. in area. All four tanks operated with bared soil surfaces until 1937. Average evaporation loss during this period 12 to 13 inches. In March 1937 all tanks planted to Bromus mollis. Vegetation on two tanks was burned in September 1937 and these tanks have since been operated free of vegetation.

Soil moisture studies: Two 1/200-acre soil moisture sampling areas established July 1934, third area established July 1936. One area maintained with undisturbed vegetation, one burned off annually, one completely denuded. Annually burned and denuded areas trenched to isolate soil block from root penetration of surrounding vegetation. Soil moisture samples collected by 3-inch increments to 48-inch depth before and after each storm and at intervening intervals of ten days. Moisture percent and moisture equivalent determinations made for each sample. Average evaporation (interception, transpiration, and evaporation) from annually burned and undisturbed areas about equal, averaging approximately 18 inches per year. Average evaporation from denuded area about 12.5 inches per year.

Interception studies: Installation established in 1937 and now includes 16 slope rain-gages and about 30 stemflow units.

6. Accomplishments during past year Lysimeters: Precipitation for rectangular lysimeters during 1938-39 season was 24.77 inches. From tank maintained with a litter cover since establishment there were 1.2 inches surface run-off, 14.9 inches percolation, and 8.6 inches evaporation; and from tank with an eroded soil covered with litter for first time in 1937, there were 2.4 inches run-off, 13.5 inches percolation, and 8.9 inches evaporation; from tank maintained with bared soil since establishment, there were 5.4 inches run-off, 7.7 inches percolation, and 11.6 inches evaporation; from tank on which litter was burned for first time in 1937, there were 7.0 inches surface run-off, 6.4 inches percolation, and 11.4 inches evaporation. On circular lysimeters there were from 4 to 5 inches more evaporation and less percolation from grass-covered tanks than from bare soil tanks.

Soil moisture studies: Soil moisture samples were collected during the 1938-39 season. Data partially analyzed.

Interception studies: The interception studies during the 1938-39 season showed that the vegetation on the undisturbed plots intercepted slightly over 20 percent of the total precipitation. Over 75 percent of the intercepted precipitation, however, eventually reached the ground as stemflow, resulting in less than a 5 percent loss of the seasonal precipitation due to surface evaporation from the vegetation.

7. Plans for next year Lysimeters: To be continued in operation without change in treatment. Results of litter study to be prepared for publication.

Soil moisture studies: Continued and extended to other areas in the chaparral region.

Interception studies: Continued and extended to other areas in chaparral region.

8. Date of completion Indefinite.
9. Assignment Kraebel, Rowe, Daniel.

January 1940

Transpiration and Other Consumptive Uses of Water by
Riparian Vegetation
"Y" Canyon

1. Field division Forest and Range Influences.
2. Work project Water utilization by vegetation.
3. Line project Tree species--transpiration and other consumptive uses of water by riparian vegetation.
4. Purpose To measure losses in water yield from a mountain watershed occasioned by transpiration of riparian vegetation.
5. Review of past work Initiated in 1931 in cooperation with U.S. Bureau of Agricultural Engineering. Four streamgaging stations constructed and detailed surveys of canyon-bottom vegetation and geology made. Development of underground leak to adjacent canyon resulted in abandoning lowest gaging stations. Paper presented at A.A.A.S. meeting in Berkeley, 1933, entitled "Vegetation of a southern California canyon." Joint progress report prepared in 1934 and summary report in 1938. Flood in March 1938, caused by 18-inch rain, completely cleared "A" fork of the "Y" and main channel below forks of all stream-bottom vegetation. "B" branch of "Y" comparatively unaltered. Weir reinstalled at mouth of "A" fork and in lower main channel to compare bare and vegetated streambottom. One climatic station installed in clear area of main channel and one under cover in "B" fork. Records collected during summer months. Instruments removed before storm flows start. Records since first report partially analyzed.
6. Accomplishments during past year Instruments were installed and data collected during summer months were tabulated. Instruments renewed for winter season.
7. Plans for next year Reinstall instruments and collect records for summer period if personnel is available. If not, measurements will be discontinued for two or three years then resumed for a like period, etc. to obtain at least intermittent data during regrowth of riparian trees. Continue compilation and summarization of data.
8. Date of completion Indefinite.
9. Assignment Kraebel, Sinclair, Storey, Weaver.

January 1940

Influence of Various Physiographic, Climatic,
and Biotic Factors on Infiltration

1. Field division Forest and Range Influences.
2. Work project Water utilization - by vegetation -
(infiltration capacity measurements)
3. Line project Infiltration: Influence of various physio-
graphic, climatic, and biotic factors on
infiltration.
4. Purpose
 1. To determine the influence of such factors
as slope, soil type, vegetation, land use,
and intensity and duration of rainfall on the infiltration capacity
of soils.
 2. To develop methods for the analysis and interpretation
of infiltration data and to further test and perfect the North
Fork Infiltrimeter.
5. Review of past work Instrumentation and operating procedures
developed and tested under field conditions.
6. Accomplishments
during past year Instrumentation and operating procedures for
the North Fork infiltrimeter perfected and
new methods for the analyses and interpreta-
tion of infiltration data developed. These have been reported in
the publication, "The construction, operation, and use of the North
Fork infiltrimeter." An infiltration study, comprising approx-
imately 100 runs, made in cooperation with the Bureau of Recla-
mation on a 100-acre watershed near Friant, California, completed
and data being analyzed for publication.
7. Plans for next year Studies to develop methods of analysis and
interpretation of infiltration data and to
perfect the North Fork infiltrimeter will be continued. Infiltra-
tion survey of the Big Creek experimental watershed, Kings River
Branch, to be started. Additional infiltration studies to be
undertaken as time and facilities permit.
8. Date of completion Indefinite.
9. Assignment Kraebel, Rowe, and other members of the
Influences staff.

RI-CAL
SOIL STABILIZATION
Watersheds

January 1940

Watersheds - Erosion Control - Mountain Meadows

1. Field division Forest and Range Influences.
2. Work project Stabilization of soils.
3. Line project Watersheds - erosion control - mountain meadows.
4. Purpose To coordinate and develop planting and engineering methods of controlling gullies in mountain meadows.
5. Review of past work In cooperation with the Regional Office of Range Management, the Experimental Station attacked the problem by training men in the control methods and by planting and giving technical direction to meadow erosion control work on 12 national forests in the Region. A mimeographed handbook, "Erosion control in mountain meadows" by C. J. Kraebel and A. F. Pillsbury was issued in 1934. Brief field examinations were made in 1938 of portions of past work on Plumas and Tahoe National Forests.
6. Accomplishments during past year Work temporarily delayed by lack of personnel.
7. Plans for next year Brief field examinations to be continued of past work to determine the suitability and efficiency of structures and methods used for restoration of meadows. Handbook to be revised with assistance from the Division of Range Research and the Region.
8. Date of completion This project should be completed within the next three to four years.
9. Assignment Kraebel, Munson.

January 1940

Relation of Forest, Brush and Grassland Cover and
Management Practices to Erosion and Soil Stability
State-wide

1. Field division Forest and Range Influences.
2. Work project Stabilization of soils.
3. Line project Watersheds - relation of forest, brush, and grassland cover and management practices to erosion and soil stability and to quality and usability of water (intensive measurement erosion surveys).
4. Purpose To determine the amount of erosion from mountain areas in relation to precipitation, vegetation, geology, soil, and other contributing factors by surveys of sedimentation in reservoirs commanding large and small watersheds and by detailed measurements from plots.
5. Review of past work Measurement of erosion from drainage units started in 1927 at

a. Barranca watershed (Devil Canyon Branch). (Refer Relation of chaparral cover to streamflow - Barranca). Annual surveys of this reservoir have been continued. Similar studies have been initiated at other locations as follows:

b. Lost Creek (Plumas National Forest) Reservoir surveyed in 1931, resurvey postponed due to negligible erosion.

c. Bell and Fern small watersheds (San Dimas Experimental Forest) 7 units. Detailed measurements started in 1933 excepting Bell #4, started 1935. (Refer project under Relation of chaparral cover to streamflow, San Dimas Experimental Forest).

d. San Dimas and Big Dalton watersheds (San Dimas Experimental Forest), reservoir surveys started by the Los Angeles County Flood Control District in 1928. Intensive annual surveys of Big Dalton Reservoir started by the Forest Service in 1934 and of San Dimas Reservoir in 1935. (Refer project, Relation of chaparral cover to streamflow).

e. Big Creek watersheds (Kings River Branch). Measurements from three small watersheds started in 1936. (Refer project, Relation of woodland cover to streamflow, Kings River Branch, Big Creek unit).

Other reservoirs including Morona and Little Rock Creek in southern California have been surveyed by the Soil Conservation Service under cooperative agreement with the Forest Service, where- by they would make the sedimentation surveys and the Forest Service would study erosion in the watersheds, the data being combined in a joint report.

Erosion measurements from plots were started in southern California during 1927 and subsequently at other locations as described under Relation of chaparral cover to streamflow - plot studies. Erosion plot studies have also been made on certain burned areas in southern California and in the Kennett area in the northern part of State.

Soil losses from Barranca watershed as measured in the reservoir for the past 10-year period from 1927-37 total 1500 cubic yards or 21,700 cubic yards per square mile. In the last 2 years the rate of erosion has increased 75 percent while the ground cover of annuals has completely disappeared. Erosion from the Fern watersheds (San Dimas Experimental Forest) with heavy chaparral cover, for seasons 1933-34 to 1937-38 was negligible; from Fern watershed No. 2 during the flood of March 1938, 5000 cubic yards per square mile; and during the December storm of 1938 after the November fire had destroyed the vegetation, 5,000 cubic yards per square mile. Erosion rates from the Bell watersheds, last burned in 1919, were about 19,000 cubic yards per square mile for the storm of March 1938 and only a trace for the storm of December 1938. It should be noted that the erosion from both the Fern and Bell watersheds during the storm of March 1938 was largely a result of stream channel scouring, whereas that from the Fern watershed during the December storm was largely a result of soil movement from the slopes. The average annual deposition in San Dimas Reservoir from 1923 to 1937 was at the rate of 1100 cubic yards per square mile of watershed, and in the Big Dalton Reservoir this annual rate from 1928 to 1937 was 4400 cubic yards per square mile. The rate of erosion from the Big Creek watersheds (Kings River) was approximately 160 cubic yards per square mile for the 1936-37 season, 10,000 to more than 20,000 yards for 1937-38 and 150 cubic yards for 1938-39. A revised report on "Erosion and cover conditions in Morena watershed" by Kraebel was submitted.

6. Accomplishments during past year All surveys made as planned for this project. Erosion rates were low for season due to subnormal precipitation.
7. Plans for next year Detailed surveys of the annual silt deposits in the San Dimas and Big Dalton Reservoirs will be continued as well as the cooperative work with the Soil Conservation Service. Plot work will be carried on as indicated in the work project mentioned above.
8. Date of completion. No definite date has been set for the completion of the reservoir survey or plot projects. However, the cooperative work with the Soil Conservation Service should be completed within the next 5 years.
9. Assignment Kraebel, Sinclair, Storey, Rowe, Hamilton.

January 1940

Revegetation for Watershed Improvement

1. Field division Forest and Range Influences.
2. Work project Stabilization of soils.
3. Line project Watersheds - propagation and testing of plants for watershed improvement.
4. Purpose Development of satisfactory planting practices for California with emphasis on the optimum methods of obtaining cleaned seed, germinating, propagating, and growing chaparral, broadleaf and coniferous species and their evaluation for erosion control on burned areas, road slopes, slides and other sites needing improvement.
5. Review of past work Seed handling. Project initiated in 1931 and expanded in 1934. Successful germination has been obtained with approximately 700 species of native California plants, of which more than 100 had heretofore failed to reproduce by seed.

Research Note No. 18, "Collecting and propagating the seeds of California wild plants" by N. T. Mirov and C. J. Kraebel published in 1937 presents methods of cleaning, storing, and germinating the seeds of 255 native species. Increased knowledge has been gained in methods of seed storage and its influence on germination.

Nursery practice and propagation. Two experimental plant nurseries have been established. The first at Devil Canyon on the San Bernardino National Forest was established in 1927 with financial aid from several southern counties. The second was established at Berkeley in 1936, in cooperation with the Regional Office.

The Devil Canyon nursery has an average annual production of 35,000 seedlings of which 30,000 are distributed to southern counties and forests for erosion control and improvement planting. The Berkeley nursery has distributed a total of over 35,000 plants to national forests for similar use.

Research projects at both nurseries include vegetative propagation and studies of germination, root development, potting methods, field nursery practice and production technique.

Planting and sowing.

Methods. Approximately 35,000 trees have been set out to test 11 methods of planting in burns and other areas of depleted forest cover along roadsides and on slope fixation projects, while additional plantations have been made to test the adaptability of species.

Firebreaks. Six plots were established on the San Dimas Experimental Forest at elevations ranging from 1500 to 5000 feet to test the effectiveness of eight succulent species for fire-resistant ground cover planting on firebreaks. Additional extensive plots were established on Los Padres National Forest.

Burned areas. Supervision and cooperation in the sowing of mustard (Brassica nigra) for erosion control on more than 40,000 acres of burned watersheds in southern California, by the Forest Service and other forest agencies.

6. Accomplishments during past year Nursery practice and propagation. Successful propagation of erosion control plants heretofore considered impossible by commercial nurserymen.

Distribution of 24,000 plants from the Berkeley nursery, for erosion control and improvement planting by national forests and other agencies.

Revision of Research Note No. 18, for publication in May 1939 as CCC Forestry Publication No. 5, "Collecting and handling the seeds of wild plants", by N. T. Mirov and C. J. Kraebel.

Planting and sowing.

Methods. Compilation and partial analysis of planting records. Continued planting and the examination of existing plantations.

Firebreaks. Results of tests indicate that the following three species may prove satisfactory for firebreak planting: Mesembryanthemum croceum, M. edule and Atriplex semibaccata.

Burned Areas. 2280 acres of the San Antonio burn of November 1938 and 9000 acres of the Arrowhead burn of November 1938 were sown to California Trieste mustard (Brassica nigra). Fern triplicate watershed No. 1, burned November 1938, was sown to mustard and surveys made to determine effectiveness of cover, area of original stand, relation of climate to subsequent year's crops, and effect of the mustard cover on natural succession.

7. Plans for next year Seed handling. Continued research in methods including the initiation of more exact germination techniques. Publication of results in form of Station Research Notes.

Nursery practice and propagation. Continued propagation of erosion control plants for experimental use and distribution. Additional research projects for weed control, watering practices, nursery technique, methods of propagation and root studies. Revision and enlargement of Station Research Note on propagation of native plants.

Planting and Sowing. Continued field trial of methods and species. Complete examination and analysis of past work for possible publication. Survey of planting requirements in southern California for watershed improvement. Continued tests of the effectiveness of mustard in erosion control. Continued studies of the phenology and succession of the mustard in Fern triplicate watershed No. 1. Lysimeter tests of effectiveness of a mustard cover for erosion control under controlled conditions, with natural plantings as checks.

8. Date of completion For project as whole: intensive investigation to be completed in next five years.
Routine examinations and observations to continue beyond this period.
9. Assignment Kraebel, Sinclair, Weaver.

January 1940

Relation of Forest, Brush, and Grassland Cover and
Management Practices to Erosion and Soil Stability
State-wide

1. Field division Forest and Range Influences.
2. Work project Stabilization of soils.
3. Line project Watersheds - relation of forest, brush,
and grassland cover and management practices to erosion and soil stability (reconnaissance erosion survey).
4. Purpose General inventory of mountain and foothill erosion in California to determine sources of damage caused by accelerated erosion.
5. Review of past work Work plan prepared by C. J. Kraebel August 17, 1934. Lack of funds have prevented active prosecution of the surveys to fiscal year 1939. During 1937 and 1938 work was conducted as an incidental reconnaissance of the flood control surveys.
6. Accomplishments during past year Project transferred to Region 5.
7. Plans for next year Handled by Region 5.
8. Date of completion Indefinite.
9. Assignment N. F. Meadowcraft.

January 1940

Development of Methods and
Stabilizing of Earth Fills and Cuts
Mountain Roads

1. Field division Forest and Range Influences.
2. Work project Stabilization of soils.
3. Line project Roads - development of practicable and inexpensive methods of permanently stabilizing unconsolidated earth fills and cuts, particularly in connection with mountain road construction.
4. Purpose Development of economic methods of preventing or controlling destructive erosion on mountain roads by improved drainage practices, slope fixation and planting.
5. Review of past work Tests of seven slope fixation treatments have been made on roads of central and southern California. Most satisfactory method devised, considering effectiveness and economy, is contour wattling, in rows staked with Baccharis cuttings and inert material, spaced 3 to 4 feet apart on slope. Some sites require mulching with hay. This treatment has proved effective in stabilizing slopes preparatory to permanent control by planting. U.S.D.A. Cir. 380, "Erosion control on mountain roads," published in March, 1936. Unpublished manuscript on "Analysis of methods of road slope stabilization." Partial survey of roads and compilation of erosion measurements were accomplished as a part of the Flood Control Surveys in southern California.
6. Accomplishments during past year Drainage improved, dips installed, 3 culverts and 30 masonry toe walls constructed on approximately 3 miles of mountain road within area burned November 1938, on San Dimas Experimental Forest. Road erosion data obtained from other areas in southern California in connection with the Flood Control Surveys.
7. Plans for next year Erosion control measures to be applied to road slopes within burned area referred to above and elsewhere on the San Dimas Experimental Forest. Several species of native shrubs will be planted on wattled slopes to test their adaptability for erosion control purposes. Detailed observations planned to determine effectiveness of improved drainage and slope stabilization measures on San Dimas Experimental Forest.
8. Date of completion Indefinite.
9. Assignment Kraebel, Ilch.

January 1940

Effect of Brush Chaparral and Grass Covers
on Local Climate

1. Field division Forest and Range Influences.
2. Work project Effect of cover on climate.
3. Line project Low vegetation: effect of brush chaparral and grass covers on local climate.
4. Purpose To study micro-climate of the different vegetation types of the chaparral region as influenced by vegetation, geographic location, topography, altitude and soil.
5. Review of past work Climatic studies were initiated in 1926 with the beginning of forest influences work in the Region. They include all precipitation, air and soil temperature, relative humidity, air movement, and evaporation studies conducted at the field stations within the chaparral region, and are collected primarily for use in conjunction with other forest influences data. A list of the principal work centers and the observations recorded at each are given in the following table:

Work center	Climatic factors							
	observed and number of installations							
	:Pre-Record	:cipi-	:Air	:mid-	:Evap-	:Air	:move-	:Complete
	:started	:tation	:temp.	:ity	:oration	:ment	:temp.	:station
	Year							
Devil Canyon	1926	10	1	1	1	1	2	1
North Fork	1929	10	1	1	1	1	2	1
Berkeley, Strawberry Canyon	1931	8	1	1	1	1		1
Bass Lake	1934	4	1			1		
San Dimas Exp. Forest	1932	375	6	6	6	6	6	4
Kings River	1935	100	4	3	1	2	1	-

In addition to the above, precipitation, temperature, and humidity records have been collected in connection with many of the smaller influence studies throughout the chaparral type. The most intensive studies of climate are those on the San Dimas Experimental Forest, where 6 completely equipped weather stations have been established to study the micro-climate within the experimental watersheds.

6. Accomplishments during past year Rehabilitation of climatic station at 5100 feet elevation and supplementary station in Fern watershed No. 1 was completed. Study of several types of rain gages on three adjacent but different facets of slope was continued. Standard 8-inch and 4-inch vertical instruments catch consistently less than the others on windward slopes. Stereo-type gage with top cut parallel to ground surface catches slightly more than any of the other instruments. Three circular catchment surfaces, exposed at ground level and parallel to slope, were added to this installation. Records of air temperature, humidity and wind movement in Barranca Watershed (Devil Canyon Branch) discontinued due to definite correlation with similar records taken at nursery.
7. Plans for next year Installations now in operation will be continued.
8. Date of completion Indefinite.
9. Assignment Kraebel and Forest Influences staff as a whole.

January 1940

Preliminary Examinations
(An Interbureau Cooperative Project)

1. Field division Flood Control Surveys.
2. Work project Flood control surveys.
3. Line project Preliminary examinations.
4. Purpose To examine and evaluate watershed conditions that contribute to floods and accelerated erosion and their economic effect on the basin as a whole with a view to determining the need for a detailed flood control survey.
5. Review of past work Work initiated during 1937 in accordance with Flood Control Act and in cooperation with two other bureaus of the Department, namely, Soil Conservation Service and the Bureau of Agricultural Economics.

Preliminary reports on the Merced group of streams, the Kings River, and the Ventura River were submitted to Washington prior to 1939; 28 public hearings held for 28 streams.

6. Accomplishments during past year During the past year, 3 public hearings, involving 13,000 square miles of watershed area, were held in cooperation with the Corps of Engineers, U.S. Army. These included Napa Creek, of 270 square miles, the Lower Klamath, of 12,900 square miles (excluding Lost River), and Sonoma Creek of 80 square miles.

Seven preliminary examination reports were forwarded to Washington during 1939, reporting on 27,400 square miles of watershed area and recommending approval of detail surveys. These watersheds are as follows:

Kaweah Tule	3,200	square miles
Kern	5,600	" "
Upper Sacramento) above Shasta Dam)	6,590	" "
Pajaro	1,290	" "
Salinas	4,980	" "
Santa Maria	1,875	" "
Fresno-Madera) Upper San Joaquin)	3,825	" "

7. Plans for next year Continue preliminary field surveys as authorized and prepare reports in co-operation with other bureaus of the Department.
8. Date of completion Fiscal year 1940-41.
9. Assignment Field Coordinating Committees 18 & 20:
Kotok (FS), Reddick (SCS), Co-chairmen;
Wilson (BAE).
Field Work Committee:
Kraebel (FS), Chairman; Johnston (SCS),
Hill (BAE).
Munson, Gleason, Fittinger (FS).
Gabbert (SCS) and staff of two.
Woodruff (BAE) and staff of two.

January 1940

Watershed Surveys
(An Interbureau Cooperative Project)

1. Field division Flood Control Surveys.
2. Work project Flood control surveys.
3. Line project Watershed surveys (detailed surveys).
4. Purpose To determine flood and erosion source areas and develop measures for the control of erosion and retardation of run-off.
5. Review of past work Under authority of the Flood Control Act of June 22, 1936, the Department of Agriculture began detail examination of the Los Angeles, San Gabriel and Santa Ana Rivers in southern California authorized for survey in June, 1938. The Forest Service, Soil Conservation Service and Bureau of Agricultural Economics cooperate in the field survey and preparation of reports. Of the 3,600 square miles in the 3 river basins, 165 square miles of mountainous watershed and 335 square miles of valley flood plain were surveyed since July, 1938.
6. Accomplishments during past year Survey report on the Los Angeles River watershed was completed and submitted to the Washington Coordinating Committee the latter part of October. Survey work on the San Gabriel River watershed is progressing satisfactorily. Field work is about 95 percent complete and work on the project as a whole for this watershed is about 40 percent complete. Selected sample areas are being examined for the purpose of developing detail plans for the unit areas. A complete analysis will be carried out for the sample areas giving specific site locations and designs of structures. All remedial measures proposed for the sample areas will be definitely located and benefits will be quantitatively analyzed for each group of measures.

Damage surveys have been made in the watershed to supplement the damage records for areas and classes of damage not previously covered by the War Department.

Intensity recording rain gages of the Friez reconnaissance type have been installed at 15 sites in the Santa Ana River watershed. These stations will supplement existing Weather Bureau and other gages now in operation.

The preparation of Survey Work Outlines, an intermediate step between preliminary examinations and initiation of final surveys, was authorized in August, 1939, for six watershed groups distributed throughout central and northern California and embracing 27,700 square miles. Three of these watersheds,

the Pajaro, containing 1,300 square miles, the Kings-Koweah-Tule, Kern group of 12,150 square miles and the Santa Maria of 1,875 square miles, were completed and the first two forwarded to Washington. The Pajaro report was approved by the Washington Committee and a survey authorized.

7. Plans for next year Completion of the San Gabriel River report and field work for the Santa Ana River project. Completion of (1) Pajaro Detail Survey; and (2) Survey Work Outlines for the Upper Sacramento Basin above Shasta Dam of 6,600 square miles, the Salinas River Basin of 5,000 square miles and the Merced County Group of 800 square miles and other survey work outlines as authorized.
8. Date of completion 1941 for present authorized three southern California streams and the Pajaro River, Balance not determined.
9. Assignment
 - Field Coordinating Committees 18 & 20:
 - Kotok (FS), Reddick (SCS), Co-chairman;
 - Wilson (BAE).
 - Field Work Committee:
 - Kraebel (FS) chairman; Johnston (SCS),
 - Hill (BAE).
 - Southern California Surveys
 - Ilch (FS), Project Leader
 - Tanner (FS), Senior Representative
 - Barrett (SCS), Senior Representative
 - with staff of six
 - King (BAE), Senior Representative with
 - staff of eight.
 - Survey Work Outlines
 - Lawrence (FS, Region 5), Chairman Committee
 - composed of Munson (FS), Gabbert
 - (SCS) and Woodruff (BAE)
 - Pajaro Survey
 - Gabbert (SCS), Project Leader
 - Gannon (SCS), Senior Representative
 - Woodruff (BAE), Acting Senior Represent-
 - ative
 - Munson (FS), Acting Senior Representative.

